MASTER

Optimizing performance management of reverse logistics in an e-commerce environment for multiple return sites throughout Europe

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Award date:
2018

Eindhoven, November 2018

Optimizing performance management of reverse logistics in an e-commerce environment for multiple return sites throughout Europe

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In partial fulfillment of the requirements for the degree of

Master of Science

In Operations Management and Logistics

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Series Master Theses Operations Management and Logistics

Keywords: Performance measurement, performance management, performance management system, performance indicators, reverse logistics, consumer returns, e-commerce, 3PL

Πάντα ῥεῖ καὶ οὐδὲν μένει

Heraclitus of Ephesus

535 – 475 BC

It should be noted that all numbers and costs presented in this thesis are fictional due to confidentiality reasons

Abstract

This research is conducted at Ingram Micro Services, focusing on a customer active in the online fashion market. The incentive for this research is the observed lack of consistency in the performance management of processing consumer returns (fashion items) at multiple return sites. Processing returns efficiently is essential due to the extremely high return rates of fashion products in the online selling channel and the expected growth of the e-commerce fashion market. To improve the performance management, a performance management system (PMS) has been developed for the individual return sites and for all return sites combined**.** For Ingram Micro Services three separate levels within the PMS were developed supporting the performance management on both a tactical and operational level. For each level, a set of key performance indicators (KPIs) and targets were designed based on the key success factors (KSFs) of Ingram Micro Services. The optimal aggregation level and review period have been determined for all KPIs. The designed PMS levels were validated using historical data. It was shown that by utilizing the designed PMS, signals of inferior performance could be detected at an early stage allowing the management to intervene on time.

Management summary

This research presents the result of a master thesis conducted at Ingram Micro Services.

Problem setting

Ingram Micro Services is a supply chain enabler providing on-demand and customized solutions to support Business-to-Business and Business-to-Consumers e-commerce needs. This thesis focusses on the performance management for the processing of consumer returns, which is one of the reverse logistics solutions offered by Ingram Micro Services. This thesis presents a case study concerning a general reseller active in the fashion industry, which will be further referred to as the fashion reseller. Ingram Micro Services processes the returns of the fashion reseller in several return sites throughout Europe. The primary motivation of the research is the lack of consistency in the performance management at the return sites.

In the literature, performance management systems are specifically designed to define, control and manage both performance and the means used to achieve these performance levels at an organizational level. Therefore, a PMS has been developed in this research to provide structure to the performance management of return sites. In order to understand what should be incorporated in the PMS and at what level of detail, the following research question was developed:

What is the optimal level of detail of the global performance management system in order to assess and improve the performance of the return handling process executed by Ingram Micro Services at different European return sites?

Research approach

Based on the theoretical background, it can be concluded that there is a lack of research on the application of PMSs in reverse logistics and the utilization of such a system on a tactical and operational level. An integrated approach was used, in which existing frameworks and techniques have been combined to design a PMS suitable for the tactical and operational management of the reverse logistics operations executed by Ingram Micro Services.

First, the process was analyzed thoroughly using business performance analytics, control theory, and systems engineering to determine the requirements and contents of the PMS at the reverse logistics sites. Second, the existing PMS framework of Ferreira and Otley (2009) was used to model the outline of the desired PMS. The outline is used to structure the conceptual design of the PMS. Third, a conceptual design for a set of PMS elements has been developed following the design process of Leinonen (in Mettänen, 2005). The design process consists of seven stages: Clarifying vision and strategy (1), describing processes (2), recognizing success factors (3), defining measures (4), pushing measures down from top management to lower levels (5), defining reporting principles (6), and how to collect data and show results (7). As an addition to the conceptual design, the modified performance record sheet (Neely, Richards, Mills, Platts, & Bourne, 1997) was used to design the actual KPIs. For each KPI, it should be determined how to calculate the KPI, an appropriate target, the review period, the required measurements, the data sources, responsible people and what to do with the results.

Results

The conceptual design approach was applied to one of the return sites to determine the outline, the contents and optimal level of detail for the PMS. An overview of the results is presented in Figure 1. Based on the desired use and the organizational structure, three different levels in the PMS have been developed: Individual, site and overall. The individual level is designed to manage the performance of individual employees. The site level is designed to manage the performance of the site. The overall level is designed to benchmark performance against the other return sites.

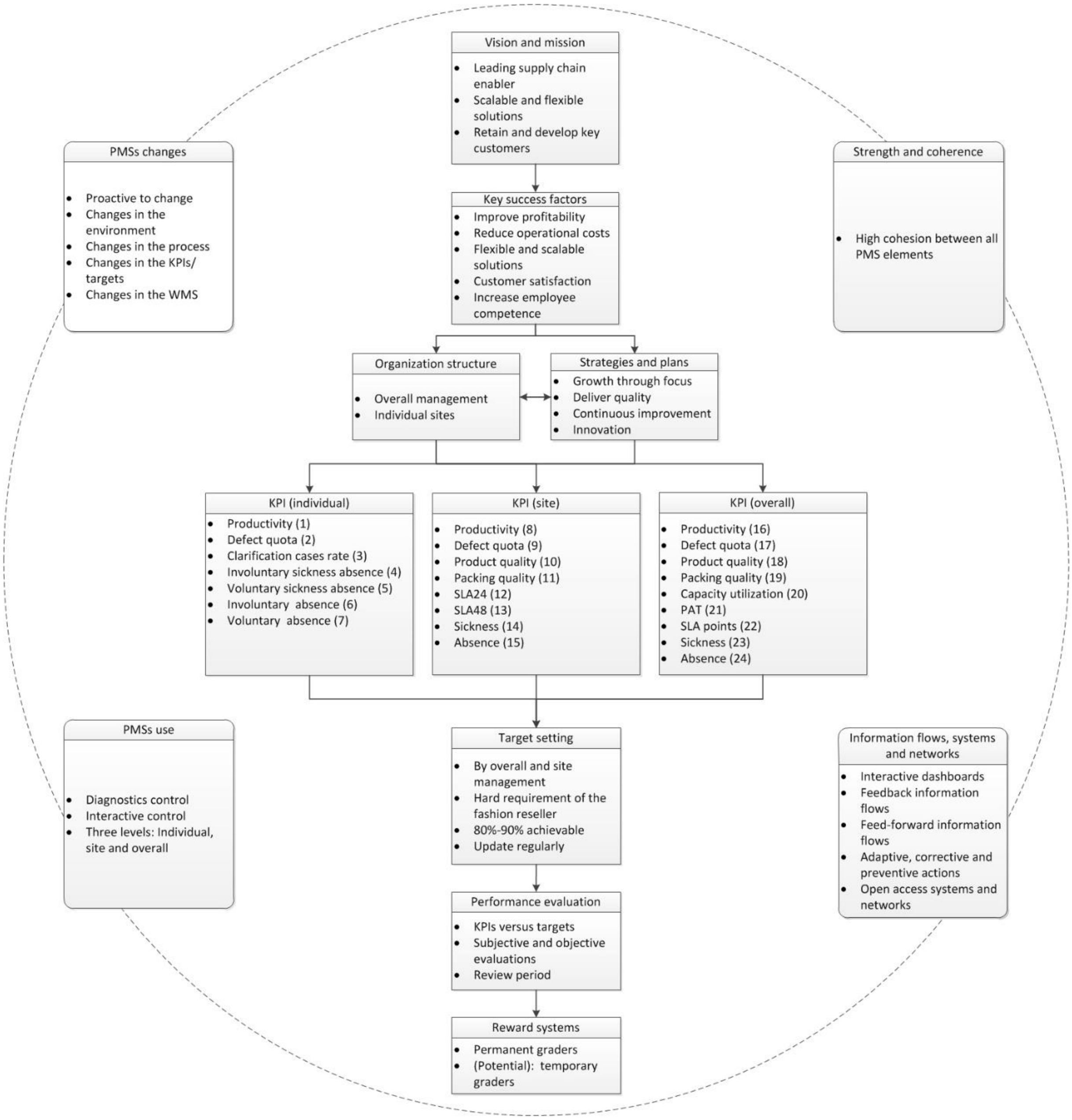

Figure 1: Designed performance management system

It was found that the optimal level of detail differs per combination of PMS level and KPI. In total, 24 KPIs were designed. Three different aggregation levels for the KPI should be used and five different review periods. The optimal aggregation level and review period for each KPI in each PMS level are presented in Table 1.

PMS level	Key performance indicator	Aggregation level	Review Period
Individual	(1), (2), (3)	Individual graders	Hour
	(4), (5), (6), (7)	Individual graders	Month
Site	(8)	Low, high and overall productivity graders	Shift
	(9), (10), (11), (12), (13)	Site	Day
	(14), (15)	Site	Shift

Overall	(16)	Low, high and overall productivity graders	Week
	(17), (18), (19), (20), (21), (22), (23), (24)	Site	Week

Table 1: Overview of PMS levels, KPIs, aggregation levels and review periods

Recommendations for Ingram Micro Services

In this master thesis, several recommendations are provided for Ingram Micro Services, which are summarized in this section.

- Implement the three PMS levels at the return sites to improve the performance management.
- Investigate the possibility to integrate the warehouse management system (WMS) of the fashion reseller with the WMS of Ingram Micro Services to create a higher level of data transparency, enabling the implementation of the individual and site PMS levels at the return sites operating with the WMS of the fashion reseller.
- Include personal identification tags to link performance data directly to graders instead of to workstations. This enables the site management to observe the learning curve of the new grader effortless and monitor the development of performance over time of all graders without additional work.
- Investigate the possibility of different productivity groups within the set of graders that may replace the applied grouping method in order to improve the designed PMS.
- Investigate the possibility to extend the WMS of the fashion reseller, allowing regular graders to process a subset of the clarification items. If the clarification cases remain troublesome for the return site, future research should determine whether this subprocess should be included in the PMS as a separate level.
- Investigate the possibility to automate the manual counting of inbound return orders and the number of outstanding return orders after shift two. By automating both measures, counting errors can be minimized and time can be saved.
- Define structural improvement plans for all KPIs, which contain specific actions for specific situations of inferior performance for specific groups of graders.
- Define a set of actions that can be utilized as a result of high rates of (in)voluntary (sickness) absence. The theory of the JD-R (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) should be used for guiding the development of actions.

Academic reflection

This research presents the design of a PMS suitable for reverse logistics operations where business performance analytics, control theory, distributed decision making (DDM) and performance management have been integrated. The core of this master thesis is the developed and applied design process. Considering the employed design to develop the required PMS elements, the model of Leinonen (in Mettänen, 2005) was used as a foundation. In this research, two enhancements have been incorporated into the model of Leinonen to develop an improved design framework. First, in the original model of Leinonen, a strict hierarchical structure is intended to push down the KPIs from top management to the lower levels. However, due to the distributed decision making and the mutual interdependence of stakeholders, the strict hierarchical structure was replaced with a DDM system to ensure the propagation of KPIs amongst the different stakeholders. Second, it was observed that there is no specific stage included in the model of Leinonen to validate the design. Therefore, in this research, a validation stage was added to determine the potential of the designed PMS levels and thus, validating the overall design.

Preface

This report presents the master thesis conducted at Ingram Micro Services in Waalwijk. This thesis is the final part of the Master of Science in Operations Management and Logistics at the Department of Industrial Engineering & Innovation Sciences of the Eindhoven University of Technology.

With great please I look back at my last five years studying in Eindhoven, but with even more pleasure I look forward to what the future will bring.

I could not have completed this master thesis without the help and support of many people. First of all, I want to thank Rob Broekmeulen for all his support, helpful feedback, expertise, and interesting brainstorm sessions. I also want to thank my second supervisor Shaunak Dabadghao for his critical opinion and valuable feedback.

Next, I want to thank my company supervisors, Mark den Dekker and Thijmen Smith, for providing me with the opportunity to conduct my thesis at Ingram Micro Services. Thank you for all your help, feedback, support, nice conversations and Friday afternoon lunches. Furthermore, I want to thank the other guys of the SPI team for their help and support. During this project, I have learned a great deal about reverse logistics and project management, but more importantly, I have learned a lot about myself.

Finally, I want to thank my mom, dad, brothers and my girlfriend for all the love and support throughout this project and my entire student career. Thank you for being there when I needed a little extra motivation and your never-ending support.

Bas Blom

Eindhoven, November 2018

Table of Contents

List of Figures

List of Tables

List of abbreviations

3PL	Third party logistic
APAC	Asia and the Pacific
B2B	Business to business
B2C	Business to consumer
BPA	Business performance analytics
CL	Central limit
DDM	Distributed decision making
DMU	Decision making unit
EMEA	Europe, Middle East, and Africa
FTL	Full truckload
FTE	Full time equivalent
ITAD	IT asset disposal
KPI	Key performance indicator
LCL	Lower control limit
MHPBT	Minimal hours performing below target
MTS	Make-to-stock
PMS	Performance Management System
SLA	Service level agreement
T&T	Track and trace
UCL	Upper control limit
UPH	Units per hour
WMS	Warehouse management system

List of definitions

Consumer return: The return of one or more articles to the seller that is initiated by a consumer before or after use, e.g., reimbursement guarantees, warranty returns, end-of-use, and end-of-life

Consumer: The customer of the fashion reseller

Customer: A client of Ingram Micro Services

Grader: Employee at the return site responsible for processing return items

Lead time: The time between the need for information and the receipt of information

Management information: Information that is key for the management and that supports decision making

Order ID: Identification method to determine the origins of a return order: Return form or track and trace code

Packing quality: Packing quality reflects whether the employee repacks the graded article according to the guidelines of the fashion reseller: Folded neatly and with the correct packing material

Product quality: Product quality reflects the grader's ability to classify the quality of items correctly (A-Goods/B-Goods)

Return form: The document added when a consumer returns an item stating the personal information of the sender and which items are returned

Return item: A single item that is part of a return order

Return order: A consumer return that is returned by an end-user to the fashion reseller, which may consist of one or multiple return items

Return policy: The specific rules a company employs applying to the consumers concerning the return of a product

Return rate: The percentage of items that are returned to the respective company compared to the items sold by the company

Review period: The time between successive evaluations of performance measures

SLA quantity: The number of orders subject to the service level agreements

Track and trace: Barcode/identification number used by order delivery companies for the tracking and identification of orders

Traditional retail store: Physical store, also known as a high street store or brick-and-mortar store

Workforce pool: Set of employees trained as graders and available for work, considering both permanent and temporary graders

1. Introduction

The research described in this Master Thesis was conducted at Ingram Micro Commerce and Lifecycle Services Europe, Middle East, Africa (EMEA), Asia, and the Pacific (APAC), further referred to as Ingram Micro Services. In this thesis, the results are presented concerning the optimal level of detail for a performance management system (PMS) which Ingram Micro Services can utilize for managing their reverse logistics processes.

1.1 Ingram Micro Services

Ingram Micro Services is a supply chain enabler for technology, commerce, and mobility industries. The company is part of the global corporation Ingram Micro Inc., which consists of three worldwide business units: Cloud, Technology Solutions, and Commerce & Lifecycle Services. In this thesis, the focus in on the EMEA & APAC branch of the Commerce & Lifecycle Services business unit.

Ingram Micro Services has increased its market coverage substantially since Ingram Micro Inc. acquired the Dutch company Docdata N.V. in 2015. Ingram Micro Services provides on-demand and customized solutions to support Business-to-Business (B2B) and Business-to-Consumers (B2C) e-commerce needs. Ingram Micro Services offers supply chain solutions such as global fulfillment, reverse logistics, small order fulfillment, value-added services (e.g., labeling, gift wrapping, and quality control), international carrier management and IT asset disposition (ITAD). Ingram Micro Services provides access to warehousing, logistics, and transportation on an international scale. Both forward and reverse logistics are core solutions offered by Ingram Micro Services. Forward logistics services provide order fulfillment for all types of products throughout the world. Reverse logistics services offer a set of options to manage the complete lifecycle of products, where Ingram Micro Services can arrange the remarketing, refurbishing, recycling, disposition or destruction of products.

1.2 Reverse logistics solutions

The focus of this master thesis is on reverse logistics solutions offered by Ingram Micro Services, which is one of the core solutions offered. The solutions Ingram Micro Services' offer cover the managing of the entire product lifecycle. Ingram Micro Services can help their partners (customers) to increase their profit margins, gain control and to maintain inventory ownership by offering an extensive range of solutions. Although Ingram Micro Services offers similar solutions to their partners, those are often unique. Every partner has particular needs to accompany their specific business processes, data management methods and IT systems. It has been observed by Ingram Micro Services that smaller companies often choose for more generic solutions and larger companies desire more customized solutions to fit their unique needs.

Nowadays, it is very popular to order products online. When those products do not match the expectations of the consumer, the consumer is likely to return the product. One of the unique reverse logistics solutions of Ingram Micro Services is the processing of consumer returns, where the larger part of the returns is directly fit to return to stock. In scientific literature, it has been observed that consumer returns have become a significant problem for the internet retailer's bottom line (Minnema, Bijmolt, Gensler, & Wiesel, 2016). However, the study of Petersen and Kumar (2009) has shown that the return rate is an optimization parameter to maximize profit. Therefore, returns can be beneficial for the bottom line. Ingram Micro Services has noticed an increasing trend in the return rate for general resellers. General resellers form the most extensive customer segments of Ingram Micro Services. Especially general resellers operating in the fashion industry experience extreme return rates, reaching up to 60%.

Figure 1-1 depicts the expected growth of the e-commerce fashion market (Statista, 2018). Combining the high return rate with the growth perspective will only result in a growing amount of returns, thus creating the motivating to study reverse logistics solutions at Ingram Micro Services.

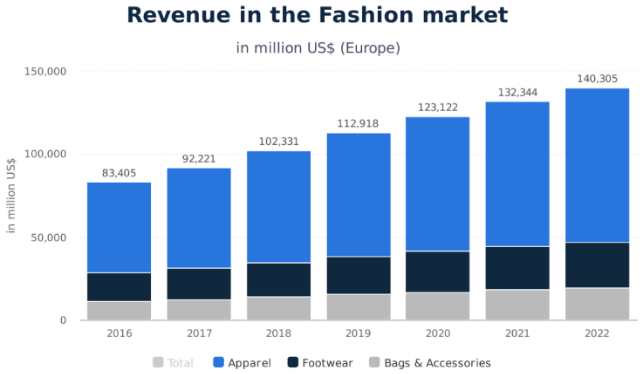

Figure 1-1: European E-commerce revenue in the fashion market

1.3 The fashion reseller

Since the solutions offered by Ingram Micro Services are very diverse (tailor-made per customer), one of the customers is selected that will serve as a case study for this master thesis. The partner that was selected is a general reseller in the fashion industry operating in the e-commerce market, further referred to as the fashion reseller.

The fashion reseller operates strictly online and employs a very lenient return policy, meaning that consumers can return their ordered product at no additional costs after purchasing. The fashion reseller reports an average return rate of 50%. Ingram Micro Services processes the return orders for the fashion reseller. When consumers return their return order to the fashion resellers, Ingram Micro Services ensures that the return items are graded on quality, where the majority is converted into as-good-as-new inventory. Ingram Micro Services processes the return orders of the fashion reseller in multiple sites in Europe. The average amount of processed returns differs significantly at the sites, ranging from 200,000 to 2,000,000 return items per month.

1.3.1 Return handling process

The return handling processes are executed according to the same methods and guidelines at the different return sites. Though, processes might differ slightly due to minor differences regarding the sites' layouts. Furthermore, handling returns is mostly a manual process. In forward logistics, automation is becoming more and more widespread, but this is not the case for processing returns.

Each return order, containing one or more return items, is processed according to the following steps, presented in Figure 1-2. The grader picks one return order and opens the box. Next, the grader checks if the return form is present (order ID) to determine the origins of the order: Consumer and returned item(s). If the return form is not present, the track-and-trace (T&T) code can be used as an identifier (order ID).

In the next step, the individual return items are graded. The grader decides whether the return item is classified as "A-Goods" or as a defect. A return item is classified as A-goods if the product and the packaging are in an irreproachable and complete state, meaning the return item is in a sellable condition. The return item is classified as a defect if the article arrives in a non-sellable condition, in which either the article or packaging shows flaws (dirt, off odors, damage, and incompleteness). A return item can show either removable or non-removable defects. Return items classified directly as A-Goods are repacked and stored as inventory (A-Goods) as well. Items containing removable defects are repaired, repacked and stored as A-Good inventory. Return items with non-removable defects are directly stored as "B-Goods". The graders repeat this process until all return items in the return order are processed. The return handling process is executed in parallel by multiple graders, where one grader works at a single workstation. The return handling process can be compared to a Make-to-Stock (MTS) manufacturing environment in which all return orders need to be processed within the requested lead time of the fashion reseller.

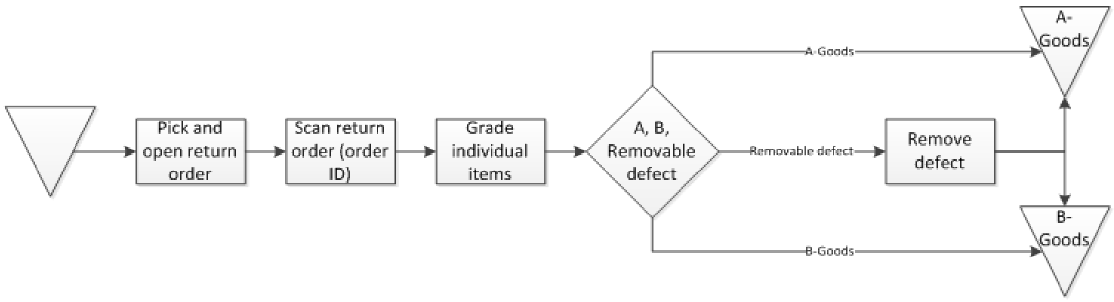

Figure 1-2: The return handling process

The core difference between the return handling process and conventional manufacturing processes, such as described by Özbayrak, Papadopoulou, and Akgun (2007), is that holding inventory and the shipment of orders are not considered in handling returns.

1.3.2 Quality and packing guidelines

The fashion reseller employs precise and extensive guidelines to determine the quality of returned items and how to repack the return items. The fashion reseller employs specific guidelines for every item category: textiles, beachwear, underwear, hanging garments, accessories, and shoes. Both the quality assessments and packing skills of the graders are checked by Ingram Micro Services and by the fashion reseller by doing internal and external audits regularly. Quality is of extreme importance for the fashion reseller since the fashion reseller fully relies on the expertise of Ingram Micro Services to deliver outstanding quality. All new employees are fully trained by job coaches to be able to work according to the strict guidelines.

1.3.3 Revenue and cost model

Ingram Micro Services employ a revenue model with a fixed revenue per processed item for the fashion reseller. The revenue that Ingram Micro Services receives from the fashion retailer per processed item differs for each return site. Considering the operating costs, Ingram Micro Services bears the load of all cost for processing the returns, which is the main risk of operating under a fixed revenue per processed item model. Therefore, it is vital to minimize the costs by stimulating operational efficiency, to improve the overall profitability.

2. Problem definition

In this Chapter, the business problem for the reverse logistics solutions is introduced. First, the performance and the reporting of performance is analyzed briefly, followed by the discussion of drawbacks resulting in the problem statement.

2.1 Performance deviations

In the current situation, every return site works according to a similar process. Each return site operates independently and reports its performance, measured by several key performing indicators (KPIs), to the overall management. The performance of all return sites is summarized in a monthly report, which is referred to as the monthly KPI report. The monthly KPI report addresses performance measures such as operating income, productivity (processed items per hour), labor cost per hour, sickness rate and absence rate (Ingram Micro, 2018). The overall management has limited insights into the performance of different sites, except the overall monthly performance. Therefore, the performances of the individual sites are considered to be black boxes for overall management.

Based on interviews with the continuous improvement manager, it was concluded that productivity is the most important KPI for Ingram Micro Services, measured in the number of items processed by a grader per hour. Due to signals from the overall management concerning deviations in performance, statistical process control was used to verify those claims. Montgomery (2009) proposed to use a $\bar{x}$ control chart to control the process averages of performance measures. Figure 2-1 presents the control chart for the performance measure productivity, where each sample contains the monthly avearage productivity levels of the different return sites of Ingram Micro Services. All formulas used in this section can be found in Appendix A. In order for a process to be in statistical control, the mean productivity per sample should be within the control limits: lower control limit (LCL) and upper control limit (UCL). In Figure 2-1 it can be observed that the mean productivity fluctuates minimally from the central limit (CL). Therefore, it can be concluded that the process is in control.

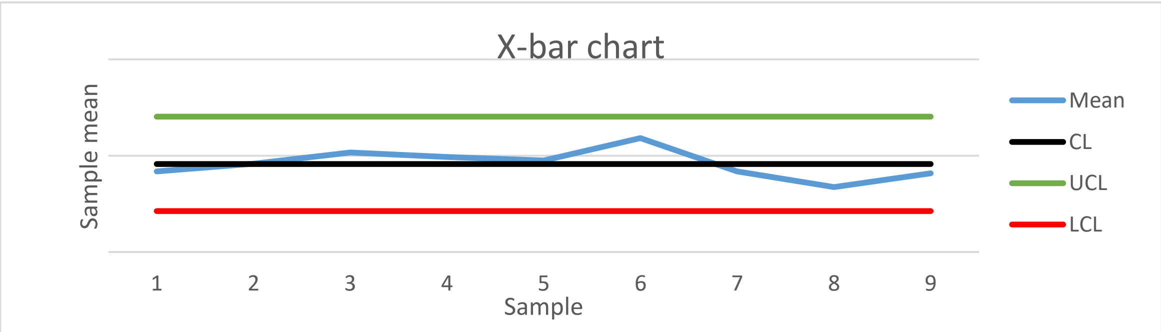

Figure 2-1: Shewhart control chart (mean):

Besides statistical control to express process potential and performance, capability indices are widely used in both the service and manufacturing industry to provide quantitative measures on the process potential and performance (Kane, 1986; Pearn & Chen, 1999; Pearn, Kotz, & Johnson, 1992; Rezaie, Taghizadeh, & Ostadi, 2006). Montgomery (2009) proposed two different capability measures, C_p and C_{pk}, where C_p reflects the performance of the process in general and C_{pk} reflects whether the performance is centered within the desired limits of the organization. Ingram Micro Services desires the productivity level to be between 85.7 and 142.9. A too low productivity results in not making enough revenue to cover the costs, while a too high productivity may result in costly mistakes being made by graders concerning quality. Given the range of the desired productivity level, both capability indices can be calculated: $C_P = 0.511$ and $C_{PK} = -0.086$. A $C_P < 1$ suggest an increased risk for not performing between the desired productivity levels. The value for C_{PK} is negative, suggesting that the mean productivity level in not within the desired range, suggesting there is a potential to improve productivity.

2.2 Reporting performance

Besides the monthly KPI report, only one of the return sites reports their performance daily to overall management. The reporting style is similar to the style of the monthly KPI report but contains considerably more detail. With daily or weekly reports, performance deviations can be detected much earlier and more precisely, in comparison with the monthly reporting structure. Comparing the similar daily and monthly reports, it was discovered that there are discrepancies between the reported figures in the two reports as well.

Based on the interviews with the reverse logistics expert, it was noted that other relevant information was not structurally reported to the overall management. For example, the forecast of returns orders developed by the fashion reseller is not incorporated in the monthly reports. Ingram Micro Services receives the forecast of the number of return orders per day once a week from the fashion reseller. This forecast of the return orders is used to develop the weekly workforce planning for the return logistics process and can deviate up to 50% per day from the actual amount of returns.

Furthermore, quality audits are conducted by both Ingram Micro Services and the fashion reseller to check the product quality and packing quality. Product quality reflects the grader's ability to classify the quality of items correctly (A-Goods/B-Goods). Packing quality reflects whether the graders repack the graded article according to standards: Folded neatly and with the correct packing material. Each site receives a quality report (internal and external), but the results of the audits are not included in the monthly report. Finally, the results of the service level agreements (SLAs) are not reported in the monthly report, which directly reflects customer satisfaction. Potential improvements can be realized by including such performance information in the reporting structure. It is likely that other unreported but essential performance measures exist and those can be determined by further research.

2.3 Suggestions for improvement

There are several shortcomings of the current reporting structure employed by Ingram Micro Services, given the observed deviations in performance. The difficulties primarily concern the assessment of different performance measures of each site, since no exact SLAs and benchmarks exist for each reported KPI. During interviews, it came forward that productivity and costs per processed item are the most important performance measures for Ingram Micro Services. Besides productivity and cost per processed unit, it is unclear which performance measures are of greater importance for the overall management and which are important on a site level. In such a way, the site performance and the global performance of handling returns cannot be assessed adequately. Furthermore, the timeliness of the reporting is a drawback as well. Reviewing the performance once per month (except for one site) makes it nearly impossible for the overall management to take action on time. This lack of accurate and on time performance assessments increases the difficulty in determining when the performance should be improved, which subprocess should be improved and what kind of performance improvement projects should be implemented.

Concluding, the following problem definition is proposed:

The lack of consistency in performance management at Ingram Micro Services combined with the highly uncertain environment of reverse logistics impedes managing the performance of the return sites, resulting in the inability of making adequate performance enhancement decisions on a tactical and operational level.

3. Research design

This Chapter describes the research design applied in this master thesis. First, the research question is introduced. Subsequently, the sub research questions are presented, supporting the research question. To finalize the Chapter, the methodology is presented.

3.1 Research question

Based on the problem definition, Ingram Micro Services should consider a framework which provides the management with information and means to monitor, assess and improve the performance of each site. There is a need for management information to enable and support the decision-making for improving the return handling process. In such a way, actions can be implemented to improve the performance of the return handling sites of Ingram Micro Services, if needed in collaboration with the fashion retailer. Broadbent and Laughlin (2009) suggest the development of a performance management system (PMS), since PMSs are specially designed for "*defining, controlling and managing both the achievement of outcomes or ends as well as the means used to achieve these results at a societal and organizational, rather than individual, level*" (Broadbent & Laughlin,p.283, 2009). Furthermore, Flapper, Fortuin and Stoop (1996), stress that a PMS can be used to offer management insights on how to reach its objectives. Finally, a PMS allows the incorporation of multiple aspects of performance that are considered relevant for the entire organization.

Ingram Micro Services must research what kind of management information needs to be incorporated in the PMS to accurately assess and improve the performance of the return handling process at the different sites. The timeliness and level of detail of the management information is an essential aspect of this master thesis. Therefore, the research question was formulated as:

What is the optimal level of detail of the global performance management system in order to assess and improve the performance of the return handling process executed by Ingram Micro Services at different European return sites?

Determining the optimal level of detail of the PMS concerns the specific management information (performance measures) required, the aggregation levels of the performance measures, the review period of monitoring and assessing the performance, and information lead time. Retrieving data for every different aggregation level and performance measure may require significant effort due to the several different data management systems used (with different owners) and different responsible employees. A tradeoff between data retrieval efforts, costs, and usefulness of the management information should be examined carefully.

3.2 Subquestions

To answer the research question, the following sub-research questions were developed:

1. What PMSs are used by Ingram Micro Services?
2. What is the intended PMS at Ingram Micro Services?
3. What factors (key drivers) influence each performance measure?
4. What is the effect of each key driver on the costs of the return handling process?
5. How can the costs related to the return handling process be reduced, based on the management information as the output of the PMS?
6. What is the appropriate aggregation level for the PMS?
7. What are the costs related to operating the global PMS?

3.3 Methodology

The reflective redesign of Van Aken, Berends and Van der Bij (2012) has been used as a general framework to provide structure to this master thesis and is presented in Figure 3-1. The reflective redesign is based on the problem-solving cycle, also developed by Van Aken et al. (2012). The key benefit of the reflective redesign over the sole use of the problem-solving cycle is that the reflective redesign focusses on both specific business problems and a generic type of business problems. The iterative nature of the reflective redesign is incorporated within the problem-solving cycle.

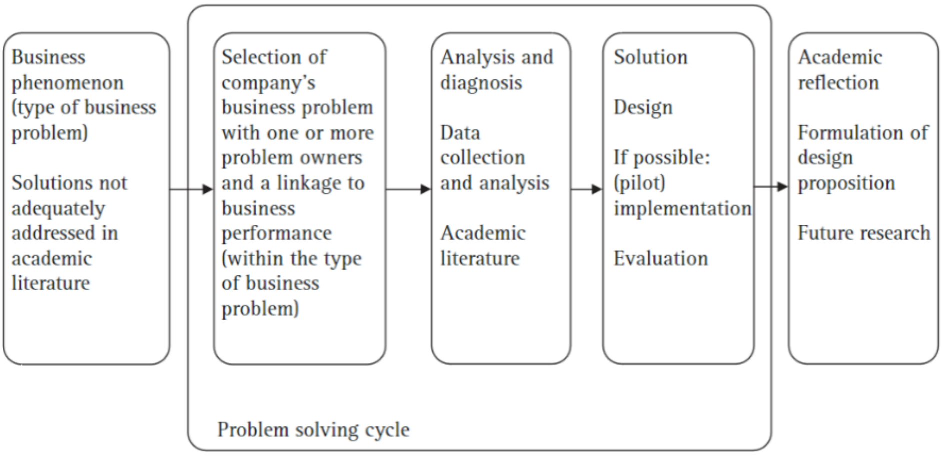

Figure 3-1: Reflective redesigns by van Aken et al. (2012)

First, the understanding of the business phenomenon is essential in the reflective redesign, where the solutions are not adequately addressed in the academic literature. The business phenomenon is presented in Chapter 1 (Introduction).

Second, the company's business problem is selected with multiple problem owners and should be linked to business performance. The company's business problem is presented in Chapter 2 (Problem definition). In the case of the return handling process, Ingram Micro Services itself, and the fashion reseller are considered as the problem owners. It is essential to understand that both problem owners view the problem from a different standpoint.

Third, academic literature considering the business problem is presented in Chapter 4 (Theoretical background). Subsequently, Chapter 5 (Current state) present the analysis and diagnosis considering the handling of consumer returns. In the analysis, a business performance analytics (BPA) approach was used since Raffoni, Visanu, Bartolini, and Silvi (2018) showed the positive effects of using BPA in performance management. BPA can be employed for identifying KPIs and KFSs by using multiple analytical methods concerning mathematics, statistics, and econometrics. Furthermore, BPA can be used to report on actual performance. By measuring, reporting and analyzing actual performance results, corrective actions can be developed (Raffoni et al., 2018). Additionally, the analysis focusses on incorporating control theory as a foundation to analyze the need for required management information and timeliness of the information. The research of In 't Veld, Slatius, and In 't Veld (2010) on systems engineering and process control combined with the concept of system dynamics developed by Sterman (2000) was used to analyze the requirements and contents of the PMS at the reverse logistics sites.

Fourth, in Chapter 6 (Conceptual design) and Chapter 7 (Detailed design), the solution design steps are discussed. In the conceptual design, a solution was designed in the form of a PMS, supported by BPA, control theory, and business dynamics. The general framework of Ferreira and Otley (2009), presenting all elements of a PMS, has been used to construct the outlines of the desired PMS. Subsequently, specific elements of the PMS were designed following the design process of Leinonen (in Mettänen, 2005) consisting of seven sub-processes. In addition to the design process of Leinonen, the modified performance measure record sheet of Neely et al. (1997) was used to design the actual KPIs. In the detailed design, the PMS has been developed based on the conceptual design and has been validated with historical data. Thereafter, the implementation plan is described in Chapter 8 (Implementation). The actual implementation of the PMS is out of the scope of this thesis.

In the final step, the conclusion is presented in Chapter 9 (Conclusion and recommendations), together with the academic reflection, future research recommendations, and recommendations for Ingram Micro Services.

4. Theoretical background

In this Chapter, the theoretical background is presented regarding reverse logistics, performance management systems and systems engineering. The theoretical background aims to understand the research topics in this research better.

4.1 Reverse logistics

In general terms, reverse logistics can be defined by planning, implementing and controlling the efficient and cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal (Rogers & Tibben-Lembke, 2001; Lambert,2011). This definition applies to all reverse logistics activities. By examining the specific type of returns, a more narrow definition can be developed.

De Brito and Dekker (2002) considered three types of returns: manufacturer returns, distribution returns, and consumer/user returns (consumer returns). Manufacturer returns are returns where products or components are recovered in the production phase of the product, e.g., raw-material surplus, quality-control returns, production leftovers. Distribution returns are returns requested by a supply chain actor, after a product is produced, e.g., product recalls and stock adjustments. Finally, consumer returns, are returns initiated by a consumer before or after use, e.g., reimbursement guarantees, warranty returns, end-of-use and end-of-life (De Brito & Dekker, 2002).

The type of returns handled by Ingram Micro Services for the fashion reseller is consumer returns. A more narrow definition for reverse logistics is more applicable to the company setting: The flow of goods from the consumer to the producer in a channel of distribution (Pohlen & Farris, 1992). In this master thesis, the fashion reseller is considered to be the producer in the channel of distribution.

4.1.1 Reverse logistics supply chain

In the research of Blackburn, Guide, Souza and Van Wassenhove (2004), a generic reverse logistics supply chain for consumer returns was developed, depicted in Figure 4-1. In the respective supply chain, consumers return their products at the point of sales. From that point, the return is evaluated and flows through the reverse supply chain to one of the destinations (disposition types): Spare components, remanufactured products, scrap or distribution. In Figure 4-2 the reverse logistics supply chain of the fashion reseller is depicted. Two significant differences can be observed in comparison with the generic model of Blackburn et al. (2004). First, the fashion reseller functions both a point as of sales and as the distributor. Second, the fashion reseller receives all processed returns, independent of the disposition type. Ingram Micro Services only evaluates the returns.

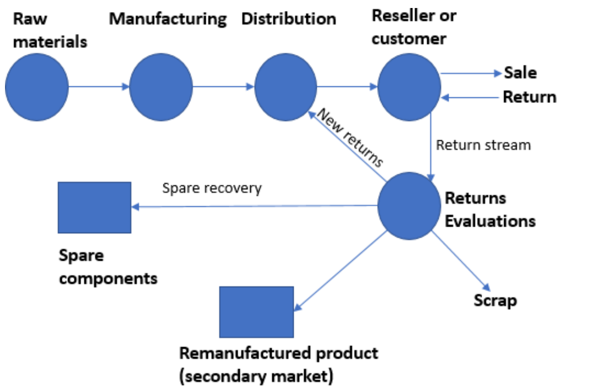

Figure 4-1: Reverse supply chain for product return (Blackburn et al., 2004)

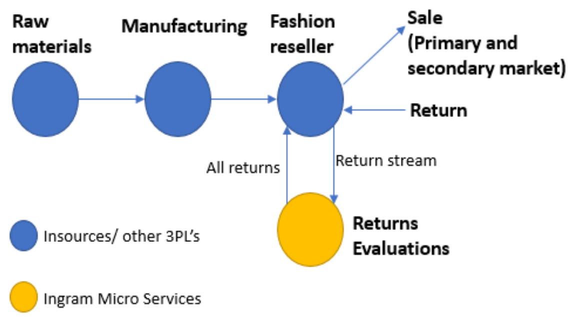

Figure 4-2: Reverse supply chain for the fashion reseller

4.1.2 Consumer returns process

In the previous section, the reverse logistics supply chain has been presented. Subsequently, the return process of consumer returns is studied, to understand all process elements. De Leeuw, Minguela-Rata, Sabet, Boter, and Sigurð-ardóttir (2016) developed a generic process model for consumer returns in the e-commerce market, depicted in Figure 4-3.

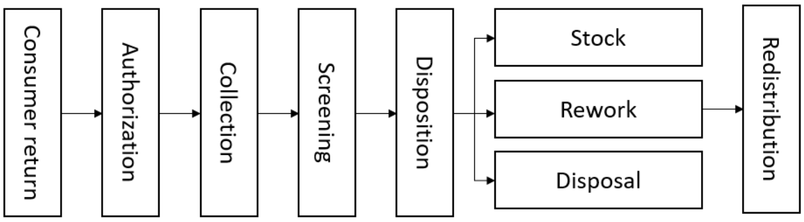

Figure 4-3: Generic return handling process model de Leeuw et al. (2016)

The process is initiated when a consumer decides to return his/her product to the reseller. A consumer can return a purchased product for numerous reasons. Examples of return reasons are that the product does not have the desired features or the product is not worth the price (Potdar & J. Rogers, 2012). The authorization of the return is a check whether the consumer is entitled to get their money back. The next step is the collection of the returns. In general, the consumer can either drop off their return order at a drop off point or a reseller can collect the return order at home (in many cases location dependent). Subsequently, the returned items are examined at a return handling site, to assess whether the return is valid and can enter the reverse logistics process (Rogers, Lambert, Croxton, & Sebastián, 2002). The following step is the determination of the disposition type. Three different disposition types are considered: stock, rework and disposal. Assessing the disposition type promptly is regarded as essential for the economic benefits of handling returns (Blackburn et al., 2004). The literature review of Blom (2018) showed that return items might lose value over time (marginal value of time) while waiting to be processed as a consumer return. After the disposition step, the products are redistributed to the forward logistics warehouse, secondhand dealers, recycling or other destinations, dependent on the reseller.

4.1.3 Third-party logistics provider

The Council of Supply Chain Management Professionals (2013) defined third-party logistics (3PL) as outsourcing all or much of a company’s logistics operations to a specialized company. 3PL involves using external companies to execute logistics processes that were initially executed within the organization (Dhayanidhi, Azad, & Narasjiman, 2011). According to professional market research, the use of third-party logistics (3PL) will continue to grow. A compound annual growth rate of 4.6% is expected until 2024, reaching a global market value of 1 trillion dollars (Global Market Insights, 2017).

It is very common for companies to outsource their reverse logistics activities to 3PL companies (Lambert, Riopel, & Abdul-Kader, 2011), such as order fulfillment, drop shipment, reverse logistics and last-mile transportation. Maloni and Carter (2006) proposed three reasons for outsourcing processes to 3PL companies: Reduce costs, improve services and focus on core competencies (buyer).

4.2 Performance management

Measuring the performance of companies has been a long lasting point of interest for both managers and researchers. Performance measurement concerns the process of quantitatively and qualitatively measuring the efficiency and effectiveness of business activities or operations (Neely, Gregory, & Platts, 2005).

The research of Lebas (1995) stressed the importance of performance management preceding performance measurement. Performance management provides a foundation and structure for performance measurement. Performance measurement is in essence part of performance management while simultaneously influencing performance management over time (Lebas, 1995).

The research of Otley (1999) laid the foundation of the widely used frameworks to shift the focus from only measuring performance to managing performance. Otley (1999) argues that five sets of issues must be addressed for the development of a framework for managing performance. The five sets of issues concern:

1. Key objectives central to the overall success
2. How to measure and assess the performance?
3. What level of performance needs to be achieved and how to set appropriate targets?
4. What reward/penalty system will be used for attaining/failing the performance targets?
5. What information flows are necessary?

Ferreira and Otley (2009) pointed out several limitations of the framework of Otley (1999): Neglecting the mission and vision of the company, not stressing the ways to use the management information and the framework is not dynamic. Therefore, they extended the framework to the PMS framework. A PMS is particularly *"concerned with defining, controlling and managing both the achievement of outcomes or ends as well as the means used to achieve these results at a societal and organizational, rather than individual, level"* (Broadbent & Laughlin, 2009, p.283). The PMS framework of Ferreira and Otley (2009) consists of twelve separate elements, extending the framework of Otley (1999) significantly: vision and mission (1), key success factors (2), organization structure (3), strategies and plans (4), key performance measures (5), target setting (6), performance evaluations (7), rewards systems (8), information flows, systems and networks (9), PMSs use (10), PMSs change (11) and, strength and coherence (12).

Furthermore, the employment of a PMS plays an essential role in supporting management by providing essential information for decision-making on the strategic and operational level (Raffoni et al., 2018). However, Bhagwat and Sharma (2007) state that PMSs are mainly used for strategically managing performance.

Research using the PMS framework of Ferreira and Otley (2009) (Broadbent & Laughlin, 2007; Collier, 2005), considered the framework as advantageous. Still, the practical implementation of the framework remains limited (Ferreira & Otley, 2009).

Raffoni et all. (2018) stressed the vital importance of data procurement and analysis to determine the primary success factors and the potential benefits of specific strategies for PMSs. Furthermore, managers can rely more on the data when data accuracy and timeliness improves, resulting in a higher decision making quality. When the data-based quality of decision-making improves, a shift from intuitive management can be initiated toward evidence-based management (Davenport & Harris, 2007; Ittner & Larcker, 2005). Raffoni et all. (2018) address in their research that the role of analytical approaches to performance management is in an emerging stage.

4.3 Systems engineering

Systems engineering is a methodology used by managers and directors for solving problems in business processes (In ’t Veld, In ’t Veld, & Slatius, 2010). Within systems engineering, processes can be managed with control loops to regulate the process and to intervene when the process is not operating under the agreed standards. In essence, a control loop is a method to ensure the stability of a system;

the system operates under the agreed norms (In ’t Veld et al., 2010). System engineering shares a great deal of similarity with PMSs, where a PMS can be represented in the form of control loops.

4.3.1. Control loop

The book of In ‘t Veld et al. (2010) discusses control loops in great lengths, and the main elements will be discussed here. A control loop can be developed for every process and is essentially a model of how the process is managed. A basic control loop consists of four steps:

1. Measure process input or output
2. Compare measurements with the predetermined norm and signal deviations
3. Determine intervention
4. Implement intervention

In control theory, processes can be controlled by means of feedforward and feedback loops. Feedforward loops are used for interventions based on deviations measured before the system is affected. Feedback loops are used for interventions based on the measurement of the output of the system.

4.3.2 Control loop for normative guidelines

To control the processes, using the appropriate norms and targets is of vital importance. In systems engineering, a differentiation is made between the development of norms and the correctness of norms (In ’t Veld et al., 2010). Norms are considered to be temporary criteria and should be revised timely in order for norms to remain accurate. Changes in the systems environment or changes within the system are the main reason to validate the current norms and may require the development of new norms (In ’t Veld et al., 2010).

4.3.3 Control theory and performance management

Carver and Scheier (1998) stated that feedback resulting from applying control theory is critical to the foundation of performance management. The application of control theory in performance management has been observed in different fields of science, such as large-scale batch processing environment (breweries) (Lees, Ellen, & Brodie, 2015) and software systems (Parekh et al., 2002). The integration of control theory and performance management in the field of supply chain management and reverse logistics has not been addressed in scientific literature.

4.4 Conclusion

Based on the literature presented in this Chapter, it can be concluded that there is a lack of research concerning several topics. First, the research using the PMS framework (Broadbent & Laughlin, 2007; Collier, 2005), consider the PMS framework of Ferreira and Otley (2009) as advantageous. Still, the practical implementation of the framework remains limited (Ferreira & Otley, 2009). Furthermore, the option of applying the PMS framework to design the outlines of a new PMS instead of describing the current elements of the PMS has not been investigated yet. Second, Bhagwat and Sharma (2007) stated that PMSs are generally used for strategically managing performance, while PMSs play an essential role in operational decision making as well (Raffoni et al., 2018). Third, Rafonni et al. (2018) showed the potential of incorporating analytical approaches in the management of performance but stressed that this field of science is an emerging field of research. Finally, the application of control theory in performance management concerning reverse logistics is unexplored territory in the scientific literature.

5. Current state

In this Chapter, the analysis of the current state of the return handling process is presented. The return handling process is executed by Ingram Micro Services at different return sites. No distinctions can be made between the reverse logistics sites regarding the processing of consumer returns. Though, there are differences between sites with regard to size, site layout, operational warehouse management system (WMS), and management style.

For the analysis, a single site of Ingram Micro Services was selected due to its geographical proximity and will serve as a reference point throughout the rest of this thesis. The analysis is divided into three main sections, where the first section presents the operational analysis of the site. The second part of the analysis focusses on the application of control theory at Ingram Micro Services. The last part discusses the drawbacks of the current performance management considering the return handling process

5.1 Operational analysis of the return site

In the operational analysis, the work environment of the return site has been examined. The first section presents the analysis of processing returns. The subsequent sections present the following topics: Forecasting, workforce composition, workforce planning, a brief financial analysis, productivity, quality management, and service level agreements (SLAs).

5.1.1 The return handling process

The process description of handling consumer returns is the result of personal experience at the respective site, combined with close collaboration with the site manager and the reverse logistics expert. The return handling process consists of three distinct subsystems, which are inbound, processing and outbound. A process model of the return handling process is depicted in Appendix B.

Inbound

Each working day, inbound freight is delivered on euro pallets in multiple distinctive timeslots throughout the day. It may be assumed that deliveries never arrive simultaneously. A delivery in one timeslot during the day will be referred to as a batch. The only information available per batch in advance is the origin of the batch and the number of pallets in the batch. On average, a pallet contains 65 return orders. Batches are processed according to the FIFO principle. In order to ensure FIFO processing, every pallet in a batch is manually labeled with the batch number. FIFO processing is one of the underlying assumptions for the service level agreements, discussed in section 5.1.8.

Processing

The subsystem processing reflects the processing of return orders. The return site has 94 workstations for grading consumer returns, where return orders can be processed in parallel. Furthermore, there are 10 workstations for clarification cases. A workstation can be utilized by maximally one grader. The layout of the return site is depicted in Figure 5-1.

Every workstation is supplied with new return orders via the conveyor belt running from bottom to top through the center line of the workstations. Occasionally, pallets with return orders are placed at the crosscut side of groups of workstations to minimize the walking distance and interference of graders working at the aisles sides.

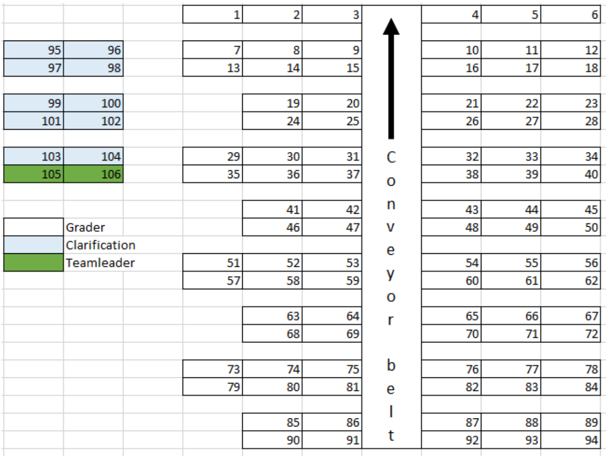

Figure 5-1: Floorplan return site

The grading process starts with scanning the return code or track-and-trace code on the return order. The next step is opening the return order and scan the barcode of the first return item in the box. Next, the return item is graded, cleaned if necessary, and repacked according to strict standards and guidelines of the fashion reseller. The grader must decide whether the return item is an A-Good, a B-Good or a clarification item. A-Goods are return items that are directly fit for resale. B-Goods are return items that are tried on, contain a manufacturing defect or are creased, thus, not fit for direct resale. Clarification items are return items that cannot be processed via the general procedure due to a missing barcode, errors in the master data, incomplete returns, empty packaging, and items damaged by clients. As depicted in the site layout, there are ten workstations for clarification cases, which require additionally trained graders to untangle the specific problems. Processed A-Goods, B-Goods and clarification items are stored temporarily in separate plastic containers at the workstations before these are processed for the outbound shipment. The graders repeat this process until all items in the return order are processed.

Subsequently, graded A-Goods are transported to the sortation area and are sorted into shoes and textile. Each return item is scanned separately and placed on a euro pallet corresponding to the correct destination of the return item, determined automatically by the WMS. A similar method is used for B-Goods in another sortation area. An additional check is done by specially trained quality employees before sorting the B-Goods to make sure those items are defects. When items are incorrectly classified as a defect, the responsible grader is notified and the mistake will be rectified.

Outbound

For the return site, several different outbound destinations are considered. However, not every outbound destination is delivered on a daily base due to the requirement of a full truckload (FTL). It can be assumed that the number of euro pallets staged in the outbound area has no impact on the processes in the other two subsystems.

5.1.2 Forecasting

The fashion reseller is responsible for forecasting the expected return orders and return items for a return site. Two different forecasts are developed, one for tactical and one for operational purposes. The first forecast, referred to as the long forecast, is a 2-month forecast of return orders aggregated per week. The long forecast is used on a tactical level, to determine the number of additional graders required.

The second forecast, referred to as the short forecast, is a weekly forecast of expected inbound return orders and the expected items/order ratio per day at the return site. The short forecast is used at an operational level to determine the required number of employees per day, including graders.

Forecasting data from December 2017 until June 2018 was used to analyze the short forecast. The short forecast and the actual inbound on order level, are depicted in Figure 5-2. A general, increasing trend can be observed with several peaks in forecasted and actual return orders. To assess the accuracy of the forecast, the mean percentage error (MPE) and the mean absolute percentage error (MAPE) were calculated, where D_t represent the actual return orders (demand) on day t and F_t is the short forecasted amount of return orders on day t.

$MPE = \sum_{t=1}^{n} \frac{D_t - F_t}{D_t} = -0.1498$, $MAPE = \sum_{t=1}^{n} \left| \frac{D_t - F_t}{D_t} \right| = 0.2455.$

Based on the calculation, a negative forecast bias can be observed; On average, the forecast is higher compared to the actual inbounds. The Welch two-sample t-test was used to conclude a significant higher mean of the forecasted orders compared to the actual arrivals (p=0.02561). Sizeable forecasting errors may have a negative influence on a companies' operational performance, particularly delivery performance and costs (Enns, 2002).

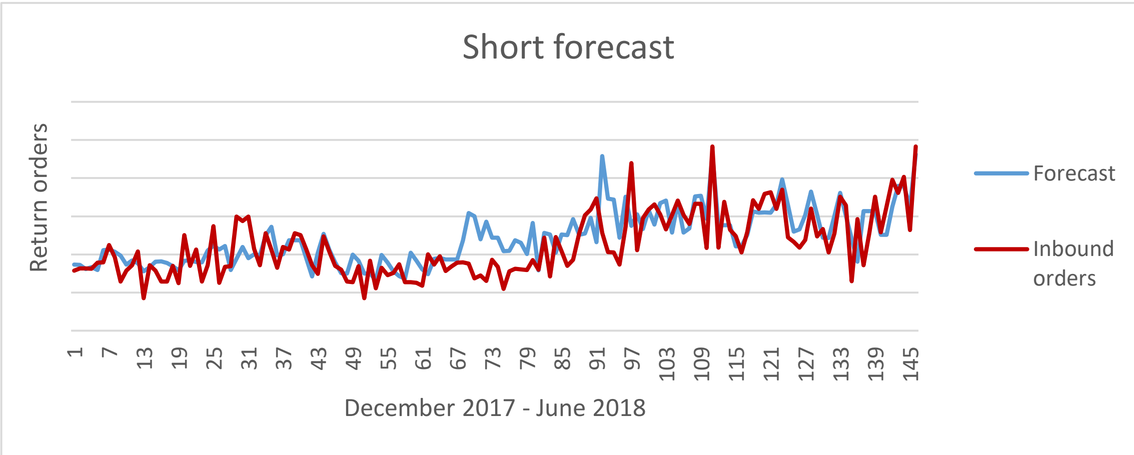

Figure 5-2: Forecasted and actual return order per day

Next, the forecasted and actual return orders per weekday are analyzed to investigate potential differences between days of the week. The results are displayed in Figure 5-3. In this figure, the difference between forecasted orders and actual arrivals can be observed very clearly. By using a one way ANOVA test, significant differences between working days for the forecasted return orders, actual return order, and the percentage errors were all rejected. In other words, no difference was found between the different working days.

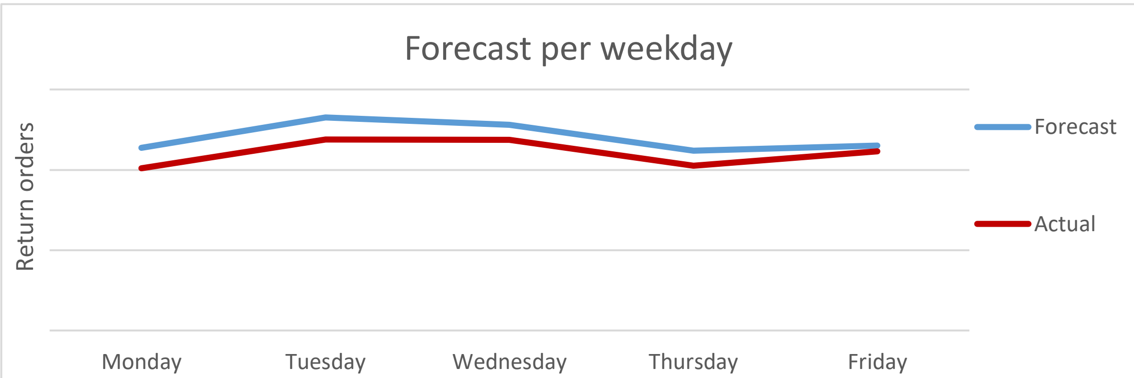

Figure 5-3: Forecast and actual return orders per weekday

5.1.3 Workforce composition

The workforce pool at the return site is composed of two distinctive types of graders which can be differentiated based on the type of labor contract: Permanent or temporary. Permanent graders have a contract from Ingram Micro Services of one year or of indefinite duration, while temporary graders have only a temporary contract via an employment agency. Permanent graders are responsible for processing a baseline of return orders, and temporary graders are used for the up- and downscaling of capacity. Furthermore, permanent graders have paid sick leave and absence, including maternity leave. Temporary graders are hired via an employment agency and are only paid for the actual hours worked. Furthermore, it is possible to discontinue the contract of a temporary worker at any time. All current permanent graders have started as temporary graders. It is customary that Ingram Micro Services offers a contract to a temporary grader after four months of good performance.

The current size of the workforce pool is considerably more substantial than the required daily workforce in order to cover for fluctuations in demand, sickness, and absence. Finally, Ingram Micro Services tries to keep temporary graders in the workforce pool, even when their services are not required on the short term, to minimize the training of additional graders.

Training

Despite the efforts of Ingram Micro Services, there is a substantial attrition rate for temporary graders. This increases the importance of an efficient training program, to ensure that new graders are trained with minimal investments while maximizing the learning curve. Furthermore, the foundation of quality management lays within the training of new employees. At the return site, training programs are offered to new temporary employees in a total of eight languages, to accommodate the needs of new workers. New graders are trained in groups, limited to four new graders per shift, in order to learn the strict norms and guidelines of the fashion reseller. The training period lasts four weeks, of which the first week the new graders receive training. The trainees are monitored closely in the training period to observe if the desired productivity level is reached. The desired levels are 43 units per hour (UPH), 57-70 UPH, 70-86 UPH, and 86-100 UPH in weeks 1,2,3 and 4 respectively. From the fourth week, the new grader should be able to work at the pace of an experienced grader. During the first week of training, all processed items are checked for flaws by the trainer, both to aid the trainee as well as to satisfy the fashion reseller.

Costs related to training

The cost related to training new graders consists of two major factors. The first factor is the cost of the trainer. The second factor considers the costs related to efficiency loss. Efficiency loss accounts for the lower level of productivity for graders in their training phase. The additional cost of training a single new grader is estimated to be 70% of the monthly costs corresponding with one FTE of temporary graders (upper bound). The larger part of the additional costs consider the costs related to the efficiency loss and are not actually incurred. The exact calculations are presented in Appendix C. Conclusively, the additional costs of training a grader are observed to be substantial. Therefore, it is vital to retain trained graders in the workforce pool.

5.1.4 Workforce planning

For the development of the workforce planning, only the graders are considered in this section. The supportive staff, e.g., shift leader, team leaders, and managers are not part of the analysis since those employees fulfill a supportive role in the grading process. It is assumed that the graders available for the workforce planning, are trained to the fullest and their performance is independent of the amount of supporting staff available to them. The planning for the required amount of graders per day is made weekly, with an equally distributed amount of graders per day during the week; the same number of graders every day in the same week. An equal amount of graders per week can be justified since there were no statistical differences found between different days of the week. Furthermore, the total number of graders per day is equally split into two shifts. During the development of the planning, costs are not considered.

At the start of developing the workforce planning, the forecasted (short and long) number of return items is reviewed. Due to the considerable forecast error, intuition and managerial experience are used to translate both forecasts in an estimate for return items for a week. Based on the estimate of items, the workforce planning is developed, where three decision variables steer the number of graders required for a given week: Expected productivity, shift length and safety rate. First, the expected productivity rate considers the expected number of processed items per hour of the current workforce pool. Second, the shift length is the number of hours a shift last. Finally, the safety rate is a rate composed of the expected sickness and absence rate. The safety rate requires managerial intuition and experience as well, to determine the expected safety rate. Special holidays such as Ascension day and Pentecost need to be considered when developing the workforce planning since sickness and absence rates are experienced as significantly higher on such days by the site manager.

To display the dynamic effect of the different variables affecting the workforce planning, an overview is made in the form of an influence diagram and is displayed in Figure 5-4. As a final remark, the managers need accurate information concerning the expected productivity, sickness, and absence rate to be able to develop an accurate workforce planning.

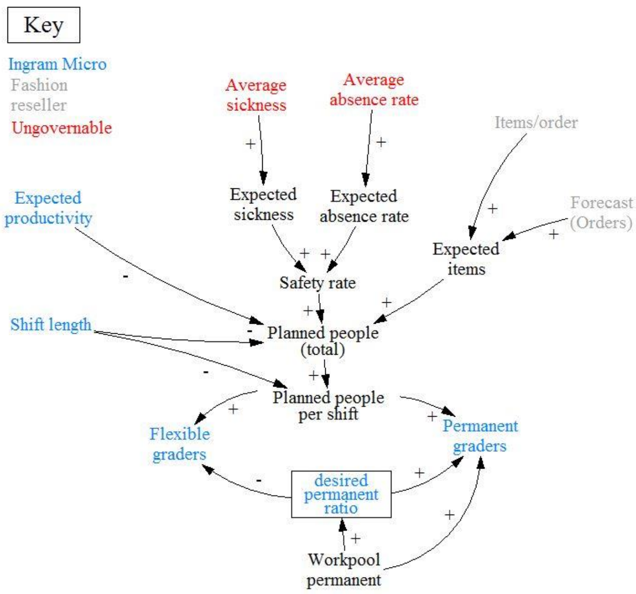

Figure 5-4: Influence diagram workforce planning

5.1.5 Brief financial analysis

Raffoni et al. (2018) suggested that for the development of a PMS, investigating the breakdown of the financial performance of a company should be the starting point. For the financial analysis, the monthly KPI report served as input data (October 2017-June 2018). Figure 5-5 presents the financial breakdown of the operating income of the return handling. Ingram Micro Services uses Activity-based costing to determine their operational costs. Exact revenues and costs are confidential, and therefore, only percentages are presented.

The purpose of the financial breakdown is to discover what factors have a significant impact on either revenue or total costs. Considering revenue first, the major contributing factor (95%) is the grading revenue. The grading revenue comes as a direct result of processed items, due to the revenue model in place. The number of processed items is dependent on the combination of productivity (UPH) and grading hours. Considering costs, costs related to the grading process are on average 75% of the total costs. From an operational perspective, such a high percentage can be justified since the more substantial part of the process consists of grading.

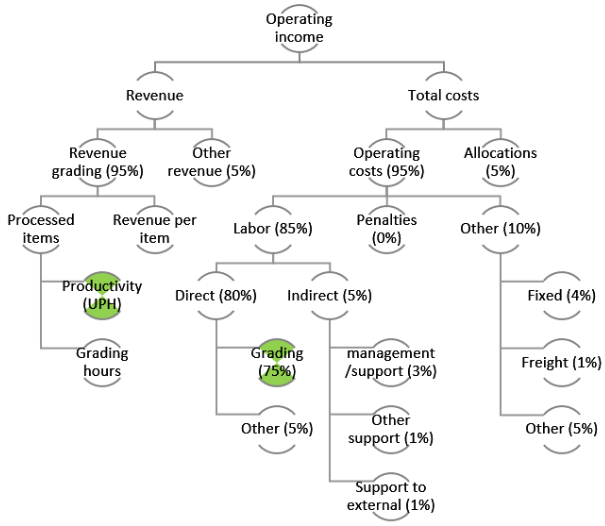

Figure 5-5: Breakdown financial performance

To finalize this section, the relation between productivity and grading hours is discussed. Interestingly, increasing the productivity by 1%, will not result in an increase in revenue, but in a reduction in costs, since less grading hours are required. This tradeoff is depicted in Figure 5-6. A clear diminishing pattern for required grading hours can be observed when the average productivity increases. The diminishing pattern suggests that the marginal gain of improving productivity decreases as the productivity level increases.

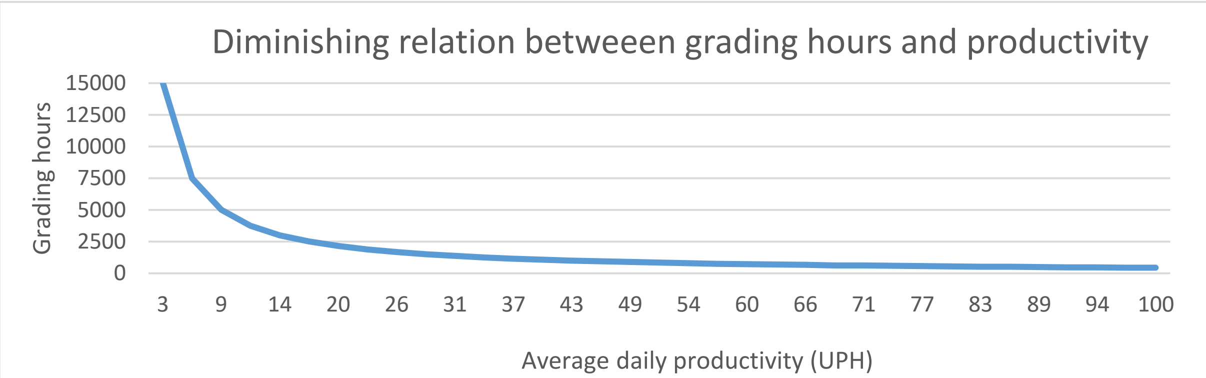

Figure 5-6: Diminishing relationship between productivity and grading hours

5.1.6 Productivity

Resulting from the previous section, the productivity of graders is considered to be critical for Ingram Micro Services. Productivity reflects the number of processed items per hour, measured in UPH. Productivity can also be presented as revenue per hour, due to the fixed revenue per processed item. However, revenue per item differs for each site. Therefore, productivity should only be presented in UPH to generalize the results. In this section, the productivity of the site is analyzed thoroughly. The available dataset does not allow for analyzing the productivity of individual graders. The data only allows analyzing productivity per employee group, over time or per workstation.

Productivity per employee group

There are two different employee groups working at the return site: permanent and temporary graders. The data used to study the productivity groups are monthly averages from September 2017 until June 2018. In Figure 5-7, the productivity per employee group is depicted over the months. The mean and standard deviation of the productivity of permanent workers are 89.97 and 17.49, respectively. The mean and standard deviation of the productivity of temporary workers are 67.43 and 10.71, respectively. With a Welch two sample t-test, the difference in means of two groups was tested. A significant difference was found between the productivity levels of permanent and temporary graders (p=0.005623)

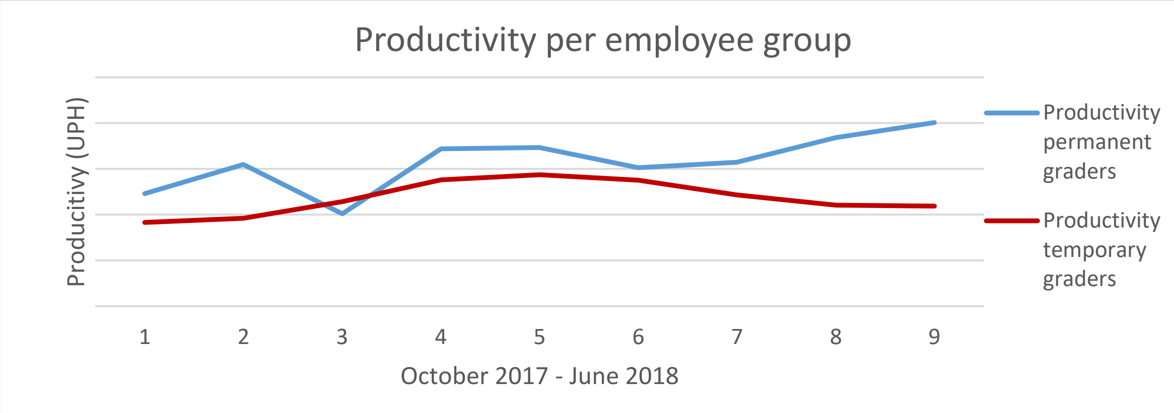

Figure 5-7: Productivity analysis per employee group

Productivity over time

The data used to analyze the productivity over time was gathered directly from the WMS over the period between October 2017 and June 2018 (until the 20th of June, the new WMS was implemented after this date) and is similar to the format of how managers review productivity data. The site processes returns in two shifts, therefore, both shifts will be analyzed separately in the remainder of this section.

In Figure 5-8, productivity per shift over time is displayed. No statistical difference was found between the means of shift 1 and shift 2 (p=0.099, Welch two-sample t-test). The downside of the available data is that no additional information is known to draw specific conclusions, e.g., specific underperforming graders or different ratios of permanent and temporary graders. For Ingram Micro Services, it is key to understand what causes the peaks and dips of productivity over time.

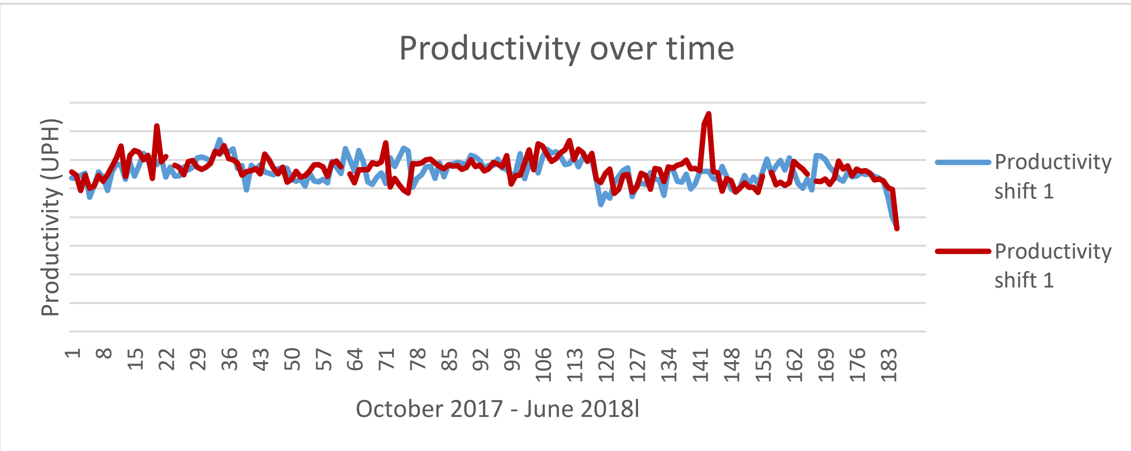

Figure 5-8: Productivity analysis per shift

Productivity per workstation

The data used in the previous paragraph was used to calculate the productivity per workstation, which is an appropriate alternative for individual productivity since equivalent graders work at the same workstations. The results are presented in the form of histograms, depicted in Figure 5-9 and 5-10. For both shifts, it can be observed that two groups exist in the data. Through an in-depth interview with the site manager, the underlying determinants for the two groups were discovered. It was concluded that the duration of employment is considered as the main determinant for productivity, where there is a positive relation between employment duration and productivity. Finally, the site manager noted that temporary graders are part of the high productivity group as well, suggesting that the difference found between temporary and permanent graders is less accurate.

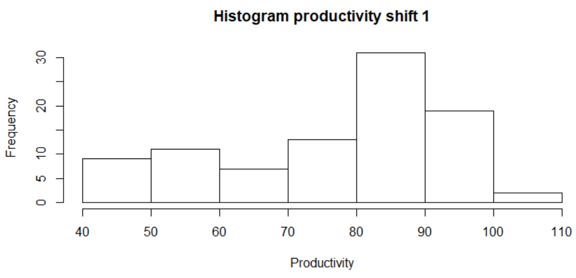

Figure 5-9: Histogram productivity shift 1

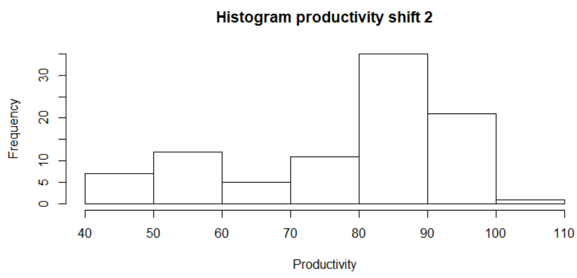

Figure 5-10: Histogram productivity shift 2

Given the two productivity groups, an additional analysis was performed to research productivity. Due to the data limitations, a proxy was used to study high and low productivity groups. Workstations were classified as high and low productivity station, serving as representatives for high and low productivity graders. High and low productivity groups were split on the mean productivity level of the last eight months. The results are presented in Figure 5-11.

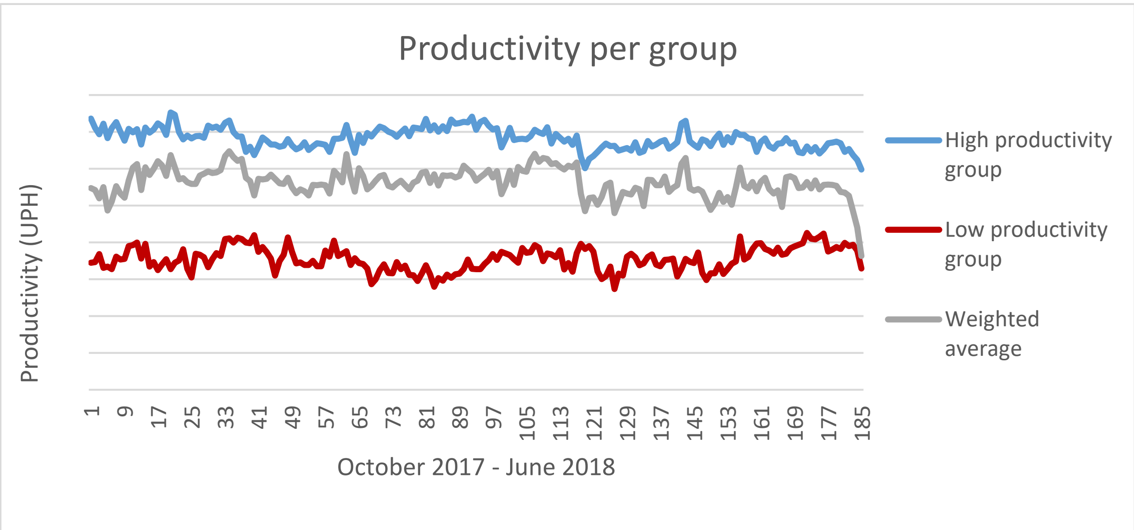

Figure 5-11: Productivity analysis per productivity group

With a Welch Two Sample t-test, a statistical difference was determined between high and low productivity groups (p<2.2e-16). This suggests that monitoring productivity as an average of all graders results in losing the visibility of the two productivity groups. Next, a regression analysis was performed to investigate the relationship between the ratio of fast graders per shift and the productivity level of that shift, presented in Figure 5-12. Since a significantly higher mean was found for fast workers, a positive relationship was expected. The correlation of the relationship is 0.812 and was determined as significant with a p-value of the slope smaller than 2.2 e-16. For the expected productivity level, the ratio of fast graders was used as an independent variable and the following linear formula was found with the regression analysis: $Expected\ productivity = 34.36 + 66.43 * Ratio\ fast\ graders$. The adjusted R-squared value is 0.645, which is fairly low, suggesting other independent variables have an influence on the variation of expected productivity. Note, this model is not used to explain the deviations of productivity, but can be used as a rule of thumb for the expected productivity, given the ratio of fast graders.

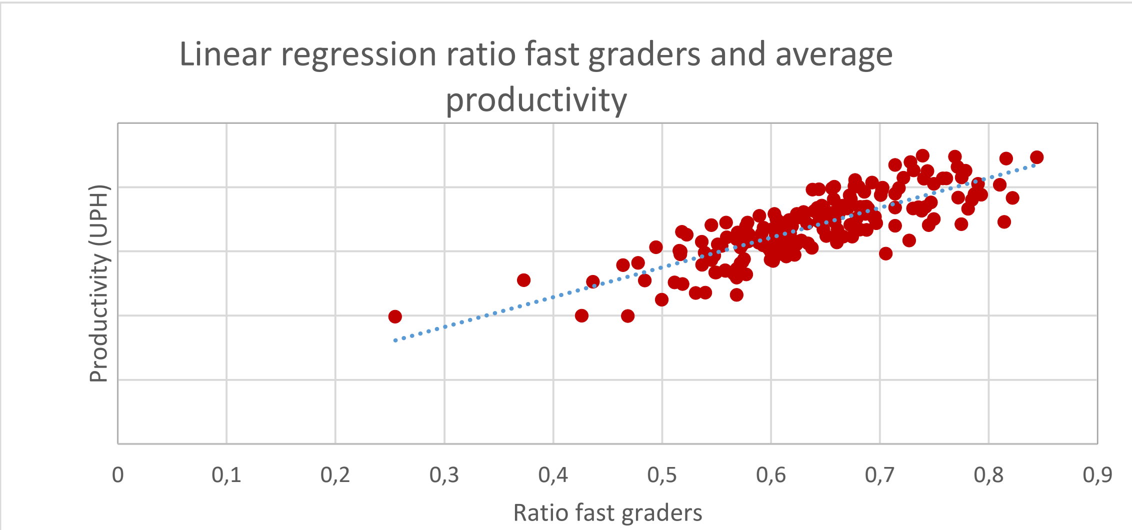

Figure 5-12: Relationship between productivity and the ratio of fast graders

Additionally, the regression equation can be used to develop a benchmark for the expected productivity level for a given ratio of fast graders. In such a way, a variable target level can be determined to assess the site's productivity level, taking into account the currently available work pool.

5.1.7 Quality management

Quality management considers managing the return handling process to deliver the promised quality level to the fashion reseller. Quality management is centrally important to Ingram Micro Services in order to satisfy the fashion reseller. Quality management is composed of three types of quality measures: Defect quota, product quality and packing quality. The defect quota reflects the percentage of defect over all the graded return items and can be measured per workstation (individual graders) or on site level. Product and packing quality represent whether graders process return items according to the strict guidelines of the fashion reseller.

Defect quota over time

Data concerning the defect quota was retrieved in line with the retrieval of productivity data for the same time interval. Figure 5-13 presents the defect quota over time, summarized over all workstations. Despite some small differences, the defect quota does not differ severely comparing shift 1 and 2. A Welch two-sample t-test concluded no difference in the mean defect quota's for the two shifts (p=0,1818). Furthermore, it is observed that the defect quota fluctuates over time in a sinusoidal pattern. This pattern might be caused by poor quality graders, but it is likely that underlying seasonality contributes to fluctuations in the defect quota over time.

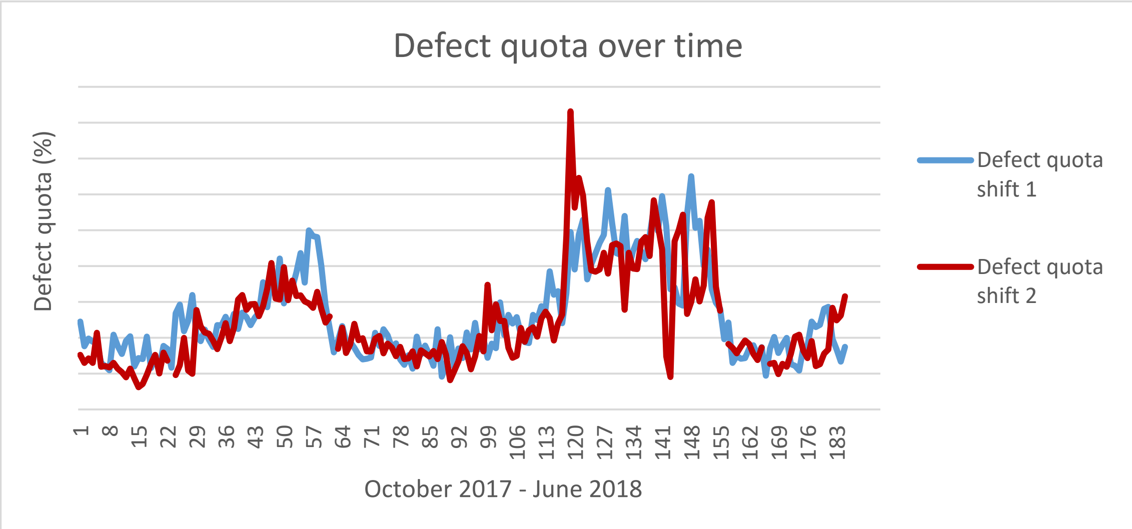

Figure 5-13: Defect quota over time

Defect quota per workstation

The defect quota per workstation was analyzed similarly to the performance measure productivity. Figure 5-14 and 5-15 depict the defect quota per workstation as histograms. Interestingly, no groups within the set of workstations were discovered. The x-as has been removed for confidentiality reasons.

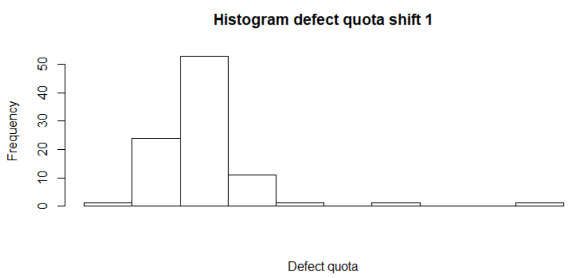

Figure 5-14: Histogram defect quota shift 1

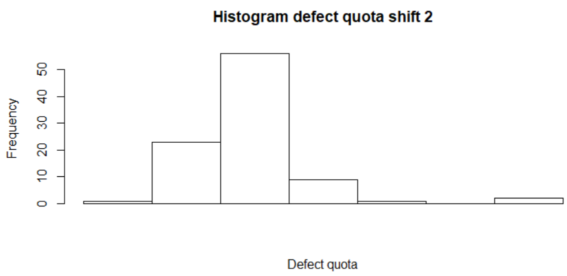

Figure 5-15: Histogram defect quota shift 2

The management believes that there is a relation between productivity and defect quota. The initial hypothesis of Ingram Micro Services was there would be a positive relationship between productivity and defect quota since defects should take less time to process. To investigate this relationship, the productivity versus the defect quota per workstation is displayed in Figure 5-16 and 5-17 for shifts one and two. Figures 5-16 and 5-17 suggest a linearly decreasing trend for the relation between productivity and defect quota with correlations of -0.34 and -0.36, respectively. The significance of the correlations was determined by linear regression, resulting in p-values (slope) of 0.00055 and 0.00131. These results oppose what was hypothesized. One of the explanations of the shift leader is the time of determining the quality category of the items. For inexperienced graders, the time to determine the quality category may outweigh the reduction in processing time of defects.

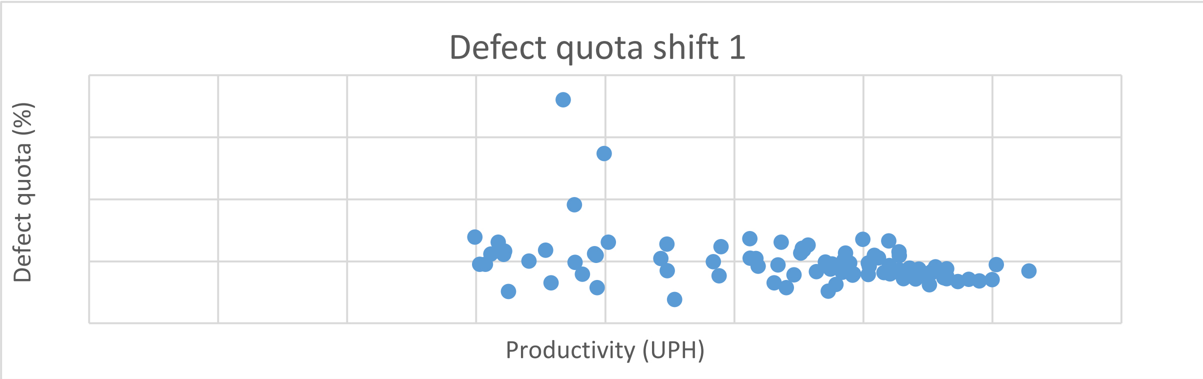

Figure 5-16: Scatter plot productivity-defect quota shift 1

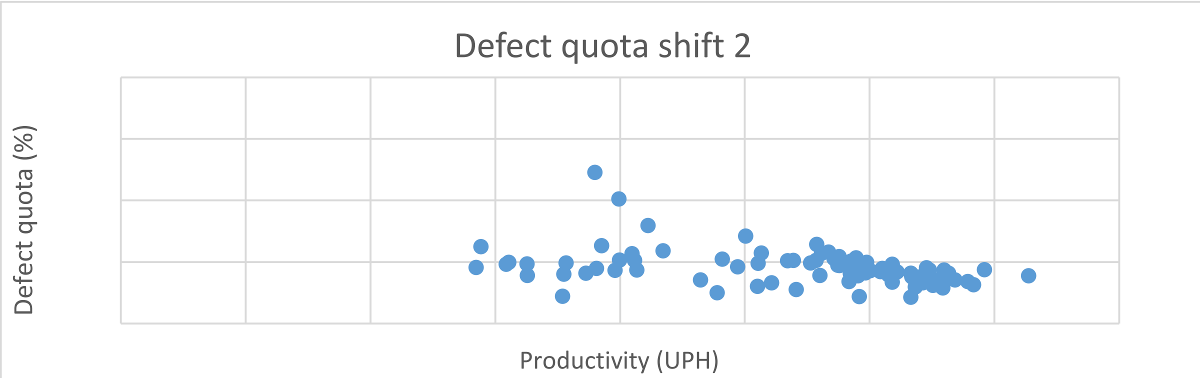

Figure 5-17: Scatter plot productivity-defect quota shift 2

Additional insight can be gained by comparing the average defect quota of graders from the high and low productivity groups since there is a negative correlation between productivity and defect quota (Figures 5-16 and 5-17). The results of the analysis are presented in Figure 5-18. By using a Welch two sample t-test, it can be concluded that the mean defect quota for high productivity graders is significantly lower than the mean of low productivity graders ($p<2.2$ e-16).

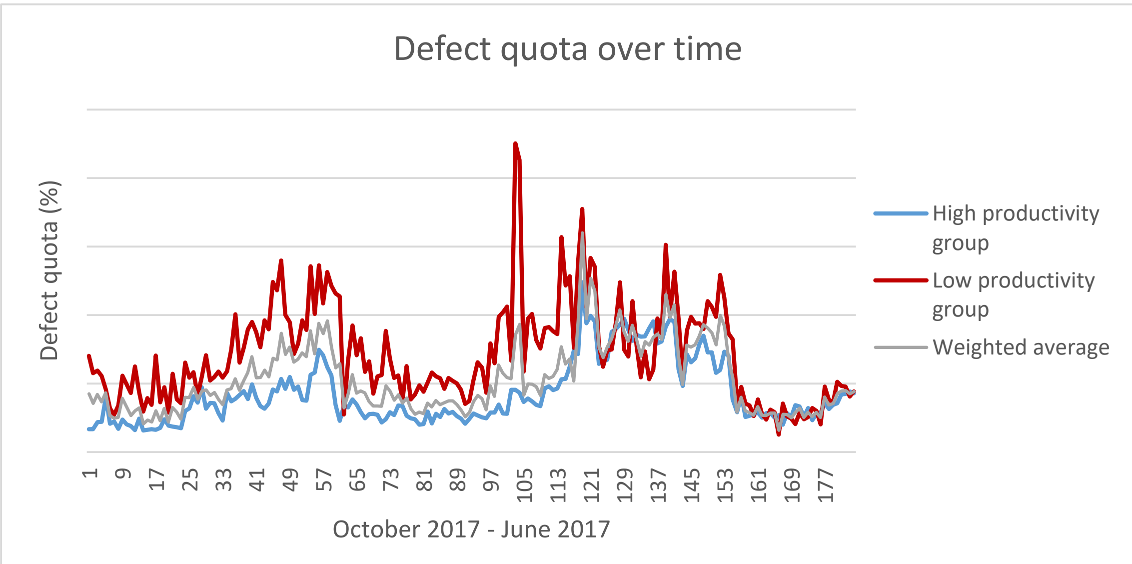

Figure 5-18: Defect quota over time (productivity groups)

Interestingly, the sinusoidal pattern observed in Figure 5-13, can also be observed in Figure 5-18 for both high and low productivity groups. Since high productivity graders are considered as good performers in general, the fluctuating defect quota over time can be considered independent of the operational performance by Ingram Micro Services. With the available data, there is no opportunity to draw any conclusions considering the true nature of the fluctuating defect quota. Possible explanations can be strictness of guidelines of the fashion reseller which may vary over time, trends in consumer's defects over time or dependent on the returned article types over time. (e.g., in the summer more bathing suits are sold, with a higher probability of being a defect). Historical data on article categories of the returned items is not available. Finally, it is possible that seasonal peaks in returned items have an impact on the defect quota. Therefore the relationship between the number of processed returns and defect quota was investigated. Using regression analysis, the relation was determined as insignificant (p=0,78), suggesting that the amount of processed items per day is not a predictor for the defect quota. Conclusively, it is key to make use of flexible targets in order to assess the defect quota. A close collaboration between Ingram Micro Services and the fashion reseller should aid in applying appropriate target levels to satisfy the fashion reseller's demands.

Product and packing quality

The product and packing quality are controlled by randomly sampling processed items and determining whether the grader processed the return items correctly. Every week, the fashion reseller samples shoes and textile items to determine the product and packing quality. The results are presented to Ingram Micro Services in the weekly quality reports composed by the fashion reseller. The product quality reflects whether the graders classified the item correctly as A-Good or B-Good. Packing quality reflects whether the item was repacked according to the guidelines. Figure 5-19 presents the percentages of products and packing quality for the first 17 calendar weeks of 2018. Interestingly, the product quality fluctuates substantially more than the packing quality. This suggests either a discrepancy between the desired quality level of the fashion reseller and the applied guidelines at the return site or graders are not working according to the predetermined guidelines.

Figure 5-19: Product and packing quality

5.1.8 Service level agreements

Finally, the SLAs will be discussed briefly to get acquainted with the service levels return sites need to adhere to. In addition to quality management, the SLAs are of equal importance to satisfy the fashion reseller and are therefore introduced here. In broad terms, there are only two SLAs, which address the processing time of orders. The first SLA, SLA24, requires that 80% of all inbound orders are processed within 24 hours. The second SLA, SLA48, requires that all inbound orders are processed in 48 hours. There are exceptions for clarification cases, which may require significant additional processing time.

The measures combined reflect the capabilities of Ingram Micro Services to process return orders within the demanded time window. Both SLA scores are assessed daily and based on the scores, SLA points (-2, -1, 0 or +1) are awarded. The total points per month may not be lower than -4, otherwise, a significant penalty cost will be incurred. Figure 5-20 presents the daily obtained SLA points and the cumulative SLA points for the first six months of 2018. The maximum (negative) limit of SLA points is only reached in June 2018. No penalty costs in June were incurred due to that the switch of operational WMS disrupted the return handling process for several days that month.

To protect Ingram Micro Services from a low forecasting accuracy (both positive and negative), the SLAs are only applicable to the number of return orders falling within the SLA quantity. Exact equations to determine the SLA quantity are presented in section 7.2.3.

Both the fashion reseller and Ingram Micro have an impact on the daily SLA quantity since the SLA quantity is dependent on the forecast accuracy (fashion reseller), the actual inbound (fashion reseller) and the processed orders (Ingram Micro Services). Therefore, it is essential for Ingram Micro Services to match the workforce capacity with the required capacity, which is considerably difficult given the forecasting error. A final remark on the SLAs is that obtaining satisfactory levels of the SLAs does not directly reflect operational excellence due to the tradeoff between grading hours and productivity.

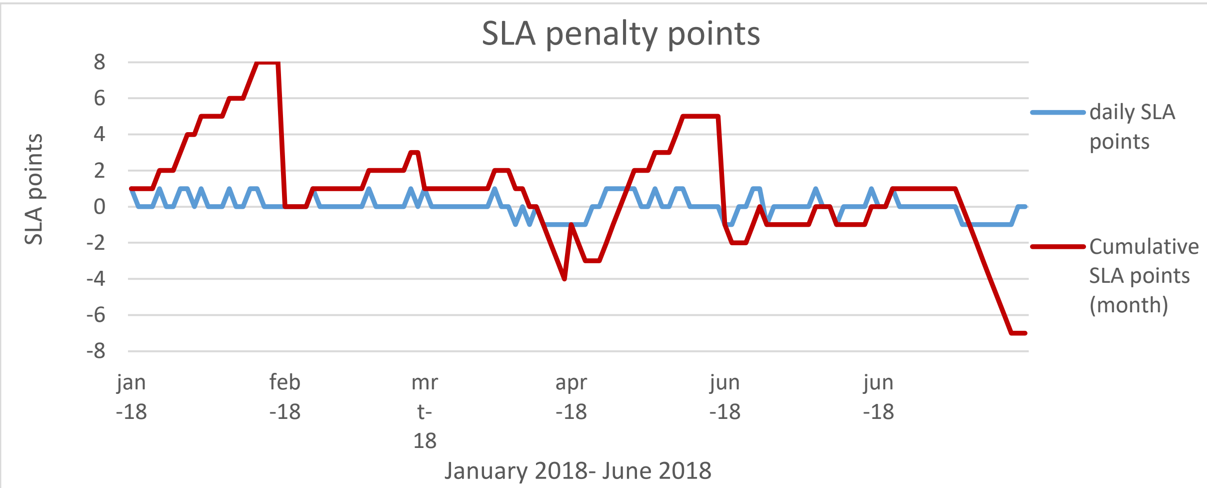

Figure 5-20: SLA points per day and cumulative per month

5.2 Control theory for handling returns

The second part of the analysis focuses on the application of control theory at Ingram Micro Services. Control loops are used to model how processes and performance are managed on site level. The book of In 't Veld et al. (2010) proposes a very elaborate technique for representing control loops in full detail. However, basic causal loop diagrams based on the research of Sterman (2000) are deemed to be more suitable to represent the different control loops for Ingram Micro Services. The choice for using causal loop diagrams is motivated mainly due to the simplicity of the modeling technique, while still being able to model any business process (Sterman, 2000). In this section, the different control loops are introduced first, together with the interrelationship amongst control loops. After that, the analysis of each control loop is presented.

5.2.1 Overview control loops and interrelationships

The different control loops are identified based on the information needs at the operational level (site level) through an elaborate analysis of the process. Five different control loop were identified which are used to control the return handling process. The five control loops are referred to as productivity control, workforce control, shift control, quality control and clarification control. The first control loop, productivity control, concerns managing the productivity level of permanent and temporary workers. The second control loop, workforce control, concerns the pool size of the permanent and temporary graders. Third, shift control concerns managing the length of shifts throughout working days. The fourth control loop, quality control, focusses on working according to the desired quality standards of the fashion reseller. The last control loop, clarification control, concerns the management of clarification cases.

In the previous sections, the strong interdependencies within the process have been observed (e.g., defect quota and productivity). Such interdependencies are also present amongst the control loops. Figure 5-21 presents the interrelationships amongst control loops. For each control loop, the measured variables, norms/targets, and interventions will be discussed in the following sections. Finally, the review period and lead time of the control loops are emphasized.

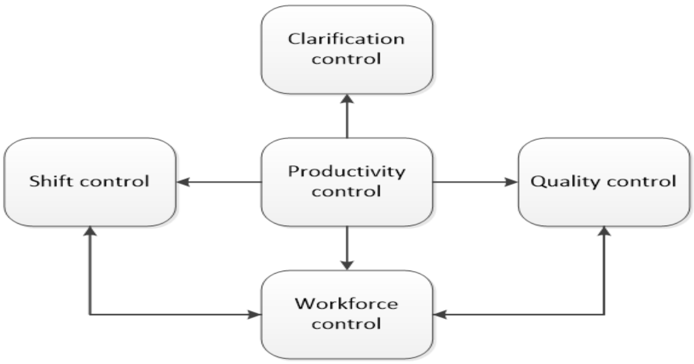

Figure 5-21: Internal dependencies control loops

5.2.2 Productivity control

Productivity control focusses on controlling the daily productivity of individual graders. An interesting remark is that during the term of the thesis, the operational WMS had changed, with a significant impact on productivity control. The core difference between the old and new WMS is the monitoring of productivity, where the old WMS allowed for real-time performance information, while the new WMS only produces daily reports with a lead time of 1 day. Real-time performance information enables to directly carry out inquiries and interventions, as a result of a discrepancy between the target and actual productivity level. With the new WMS, the productivity can only be assessed retrospectively since productivity report has a delay time of one day. Therefore, the review period and the lead time of productivity are both one day. The productivity is measured per hour and per day for each workstation. Until now, no personal identifiers are used to track individual productivity causing significant additional manual labor for the manager to link graders to specific workstations. It is strongly advised to implement personalized identifiers to ease the monitoring of productivity. Figure 5-22 presents the causal loop model of productivity control and provides a clear overview of dependencies between variables. The target level for productivity is currently set at 100 UPH.

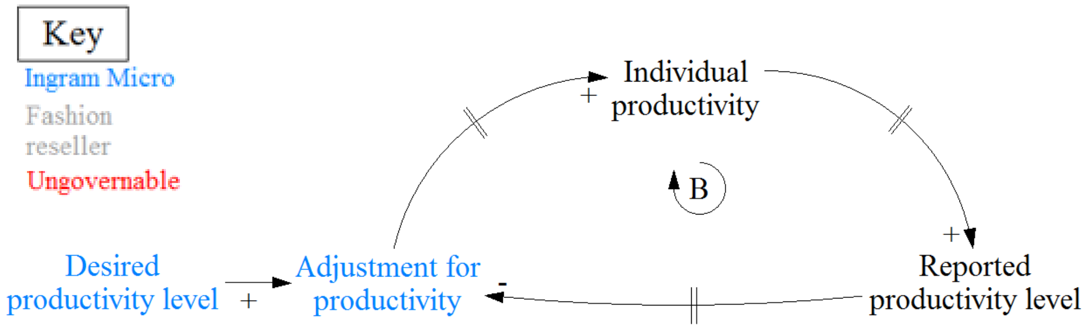

Figure 5-22: Productivity control

The variable adjustment for productivity is a general method to represent the different kinds of intervention methods. Deployed interventions differ significantly and can range from an inquiry in the low productivity to involuntary attrition of a grader. Interventions should be triggered when the reported productivity level of individuals does not correspond with the target level. It takes at least two days to notice implemented interventions, since it takes one day to notice the deviation and to trigger interventions, and it takes another day for it to show in the next productivity report.

The balancing loop between adjustment for productivity, individual productivity and reported productivity level suggests that an increase in adjustment for productivity will eventually balance out with a decrease in adjustment for productivity.

5.2.3 Workforce control

The workforce pool consists of permanent and temporary graders. The management of the workforce pool reflects the decision making of hiring and firing graders. Interviewing the site manager showed that permanent graders are very unlikely to be hired or fired, due to legislation and the high level of required performance. For temporary graders, this is the opposite. Therefore, a separate control loop is devoted to managing the workforce pool of temporary graders. The causal loop defining workforce control is presented in Figure 5-23.

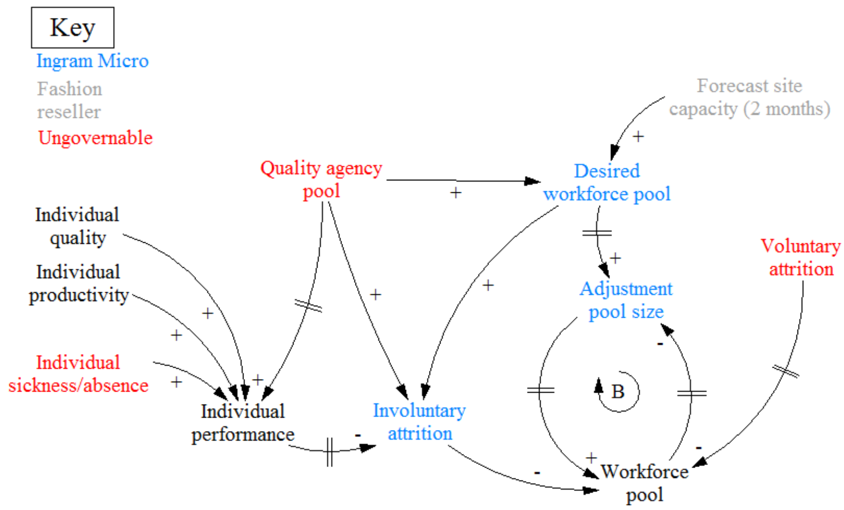

Figure 5-23: Workforce control

At of the core of the control loop is the variable adjustment pool size, which is similar to what we have encountered in the previous control loop. Adjusting the pool size, with as results hiring or firing graders, is triggered when a discrepancy occurs between the desired pool size and the current pool size. A discrepancy may be caused by a combination of involuntary attrition, voluntary attrition and the level of the desired workforce pool. This relation corresponds with a balancing control loop.

Involuntary attrition

Involuntary attrition is dependent on the individual performance of graders, where a low performance over a more extended period of time can result in the discontinuation of the employment. The determinants of individual performance are individual quality, productivity, sickness, and absence. The variables individual quality and individual productivity (from productivity control) have a review period of one day, due to the information lead time. The variables individual sickness and individual absence have a review period of 0.5 days since the return site works in two shifts. It is assumed that graders never work during both shifts. Furthermore, the workforce planning is developed weekly. Therefore, the review period of involuntary attrition should be equal to one week and may result in the immediate dismissal of graders (no lead time).

It is important to understand that Ingram Micro Services has only little influence on who the agency supplies as new graders and is currently experiencing difficulties with finding appropriate graders. The unavailability of appropriate new workforce results in lower involuntary attrition rates since no better employees can be found.

Finally, the workforce pool can also be reduced due to lower future capacity requirements. Ingram Micro Services should tread carefully concerning reducing the workforce pool, since often reducing the workforce pool may have adverse effects on finding graders in the future.

Voluntary attrition

Voluntary attrition occurs when graders quit working at Ingram Micro Services voluntarily. Several diverging reasons were uncovered through interviews ranging from not getting a vacation day for certain holidays to being discontent about the operational WMS. Ingram Micro Services attempts to uncover why an individual leaves Ingram Micro Services voluntarily but is often not able to retrieve the underlying motivation. Since substantial resources are committed to training new graders, voluntary attrition should be monitored closely. Finally, voluntary attrition can occur at any moment of time, but it is assumed that graders only quit at the end of the week, since their payment arrangements are handled per week. Therefore, the review period of voluntary attrition is one week. It is difficult to assign a specific lead time for voluntary attrition since the total workforce pool is substantially larger than the weekly engaged workforce pool. The lead time of voluntary attrition is therefore assumed to be two weeks.

Hiring new graders

Hiring new graders is supported by a mismatch between the current workforce pool and the desired size of the workforce pool. The decision to hire additional graders is also made on a weekly basis, with a maximum of eight new graders per week. The time between the decision of hiring new graders and the initiation of the training phase is one week.

Finally, the relation between workforce control, productivity control and quality control is observed in the part where the individual performance of graders is determined. Both productivity and quality control serve as input to monitor the overall performance of graders in for the workforce control loop.

5.2.4 Shift control

The control loop shift control supports the decision making of whether a shift should be shortened or not. Due to the substantial, and often negative, forecasting error the workforce planning might exceed the required workforce capacity for a day. When the remaining outstanding orders for a day are approaching the desired level of inventory at cutoff, the shift should be shorted. It is assumed that only shift two can be shortened.

Figure 5-24 present the causal loop diagram of the shift control. The core function of the shift control is to make sure that the daily ending inventory at cutoff is equal to the desired inventory at cutoff (1 FTL≈35 pallets≈2275 order). A nonzero desired inventory at cutoff is required as starting inventory for the next shift at day t+1 and is therefore independent of the expected inbound order of day t+1. The decision of shortening shift two can be made at any moment during the second shift since the process of grading returns can be stopped at any moment in time. Therefore, the review period should be set equal to one hour. The lead time of the decision may vary between 0 and 0.5 days, dependent on when the decision is taken.

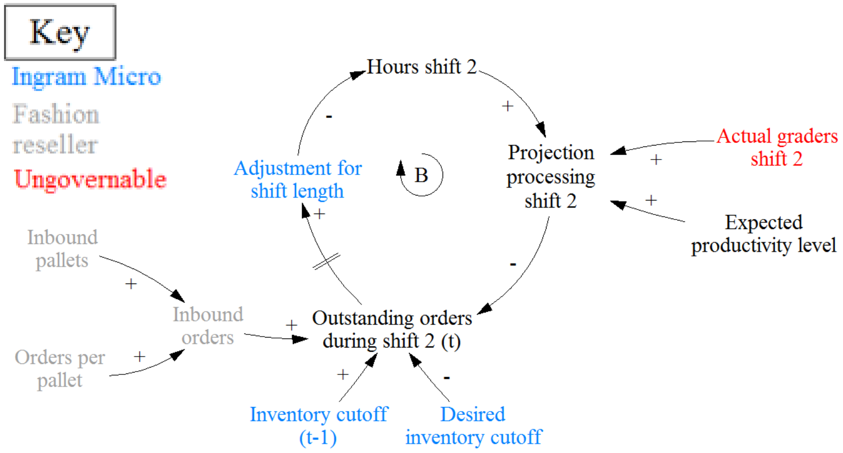

Figure 5-24: Shift control

Shortening shift 2 is dependent on the outstanding number of return orders, the desired inventory at cutoff and the projections of processed order during shift 2. The number of outstanding orders is equal to all the unprocessed return orders at the return site (at the moment of the decision) and the expected arrivals (in pallets). The projection of processed order is the multiplication of the actual graders working in shift 2 and their expected productivity level. Deployment of this control loop should only be considered when the forecast error is negative. Furthermore, it must be checked first, whether SLA24 and SLA48 have already been satisfied, although it is highly improbable that SLA24 and SLA48 are not satisfied when the inventory at cutoff is close to the desired level.

Finally, the relation of productivity control and shift control can be observed in the measurement part of shift control. The projection of processed items in the second shifts is dependent on the results of productivity control. Furthermore, a relation was found between workforce control and shift control, since the productivity level of permanent and temporary graders differ significantly (section 5.1.6), influencing the projection of processed orders.

5.2.5 Quality control

The control loop quality control concerns the management of quality and should be considered as the most essential control loop from the fashion reseller's perspective. The control loop quality control is presented in Figure 5-25. The core of the control loop is twofold, where one part considers the individual quality level of graders and the other part concerns the site's quality level.

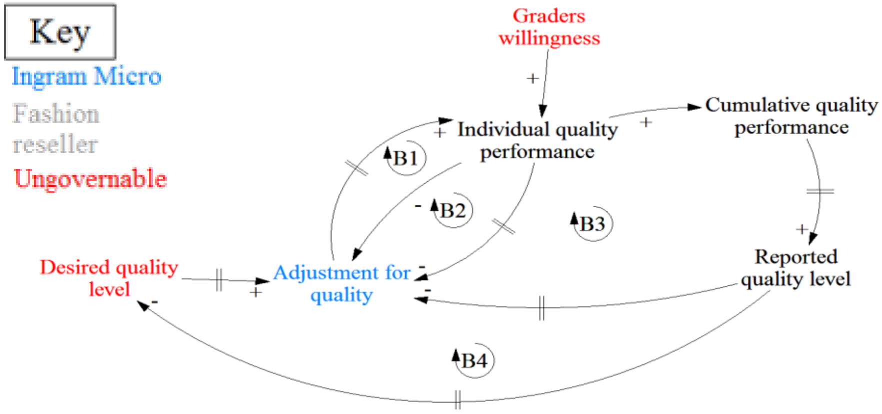

Figure 5-25: Quality control

The individual quality level (per workstation) can be monitored in two ways, where the first is reviewing all items categorized as a defect for assessment errors. This final check is done by specialized quality employees and is executed continuously. Second, the defect quota is reported in the same report as the productivity, with the same review period and information lead time.

The overall quality level, concerning all workstations, can be monitored by the defect quota, product quality and packing quality. The overall defect quota is reported every day to Ingram Micro Services and is also reviewed daily. Furthermore, both Ingram Micro Services and the fashion reseller measure product and packing quality. Ingram Micro Services measures the product and packing quality daily by the random sampling of items throughout the day. When a mistake is found, the responsible grader is notified. The fashion reseller measures the product and packing quality every week and communicates the scores of the previous week every Monday. Both measurements reflect the overall quality level, although the measurements of Ingram Micro Services can be traced back to individual graders as opposed to the measurements of the fashion reseller.

Three targets are used within this control loop, as comparisons for the measurements. First, an unquantifiable target is used to determine whether a defect is indeed a defect. Only experienced workers perform such quality checks. Second, the target for the defect quota of both the individual and overall performance is between 4-6%. During the visit at the return site, it became clear that the desired quality level can also be used as a decision variable based on the previous defect quotas and the demand of the fashion reseller. Therefore, the weekly overall quality levels should determine the target for the defect quota of the next week (balancing loop 4). Finally, the product quality and packing quality should be below 4%, meaning that only 4 out of 100 sampled items may contain flaws.

Four different interventions can be used based on the results of this control loop. First, individual graders can be confronted when mistakenly grading A-Goods as defects, or when a product of packing error is discovered. This helps the grader not to make the same mistake in the future (balancing loop 1). The second and third interventions (balancing loops 2) are deployed when the individually measured defect quota surpasses the target. The second intervention is in the form of a confrontation and inquiry for the cause of the problem. The third intervention is a more extreme measure if the defect quota surpasses the target too often, and may result in a discontinuation of the contract. The last intervention is based on the overall quality level. When the overall quality level of a day surpasses the desired quality level, additional attention the next day must be placed on product quality (balancing loop 3).

Finally, the relation of productivity control and quality control can be explained by the results of section 5.1.7, showing the relation between productivity and defect quota. Altering the desired defect quota may result in a change in productivity. The relation between workforce control and quality control comes forth since the individual performance of a grader is also dependent on the individual quality level of the grader, controlled in the quality control loop.

5.2.7 Clarification control

The final control loop, clarification control, concerns managing the clarification cases rate and is presented in Figure 5-26. Clarification control is essentially the same as productivity control, but the controlled measure is the clarification cases rate. The site manager noted that items graded as clarification cases are incorporated in the productivity levels of individual graders. Therefore, a high clarification cases rate might signal graders that are misusing the system. The clarification cases rate should be monitored per employee similar to individual productivity control. There is currently no norm or target available for clarification cases rate, simply because the problem emerged very recently. When high clarification cases rates are detected, individual graders are confronted and will be monitored more closely in the future.

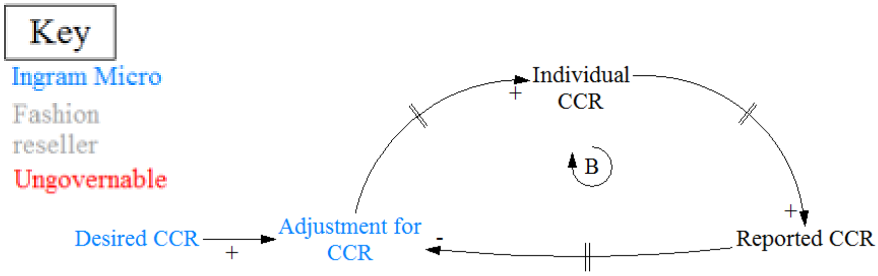

Figure 5-26: Clarification control

5.2.6 Summary control loops – measurements

Table 2 present a summarized version of all five control loops. For each control loop, the measurements, norms/targets, the review period and the lead times are presented.

Control loop	Measurement	Norm/target	Review period (working days)	Lead time (working days)
CL1	Productivity per workstation	100 UPH	1	1
CL2	Individual productivity	100 UPH	1	1
	Individual quality	4-6%	1	1
	Individual sickness and absence	-	0.5	0
	voluntary attrition	-	5	10
	Workforce pool	Desired pool size	5	0
CL3	Inbound orders	-	1	0
	Inventory cutoff (t-1)	Desired inventory cutoff	1	0

	Actual graders shift 2	Planned-10%	1	0
CL4	Individual quality (1)	-	0	0
	Individual quality (2)	4-6%	1	1
	Overall quality	4-6%	1	1
	Overall quality (fashion reseller)	4-6%	5	1
	Product and packing quality (Ingram)	<4%	0	0
	Product and packing quality (fashion reseller)	<4%	5	5
CL5	Clarification cases rate	-	1	1

Table 2: Summary control loops

5.2.7 Validation control loops

Through joint interviews with the site managers, shift leader, IT engineers, and the reverse logistics engineer, all relations presented in the control loops were determined.

5.3 Current performance management

To finalize the analysis of the current state, this section presents the shortcomings of current performance management resulting in a brief diagnosis. Three main topics are considered in this section: Control loops, KPIs and the reporting structure.

5.3.1 Control loops

The control loops used by Ingram Micro Services have been presented in section 5.2. All presented control loops are utilized on the site level. No control loops exist on a higher organizational level to control the handling of the returns, because each site is managed individually and operates independently of the other sites. However, considering the development of norms and targets, several norms and targets should be determined by the collaboration of management levels of Ingram Micro Services and the fashion reseller.

Finally, a lack of supportive data has been observed throughout the analysis, impeding the structural application of the control loops. A properly designed PMS should provide the required data at the proper aggregation level when needed to support the decision making throughout the organization.

5.3.2 Key performance indicators

In addition to the control loops, several of the KPIs used by Ingram Micro Services have been examined. It is critical to consider KPIs that are of great importance for the site level and the overall management level. On the site level, the most important KPIs are productivity, quality, and the SLAs. On the overall management level, based on observations of the KPI report, the focus is on productivity and costs. Discrepancies between important KPIs considering the different layers of management should be examined carefully. For example, SLA24 and SLA48 are dependent on the number of processed items per day. The number of processed items per day, however, can be influenced by two decisions: higher productivity per hour per grader versus more graders. This trade-off should be taken into account with the management of operational performance. Concluding, it is essential that the used KPIs on different management levels should be aligned to decrease the risk of pursuing local incentives.

5.3.3 Improvements reporting structure

The final part of this section concerns the reporting structure. Currently, from an overall management point of view, the performance of local sites is observed as a black box. A monthly KPI report is produced to provide a summarized overview of the performance and enables the benchmarking against other return sites. The monthly KPI report is foremost suitable for strategic management

For tactical and operational management, however, the monthly KPI report is considered to be too superficial to support adequate decision making. To overcome such a problem, the state of information needs to be improved for overall management, based on the concept of distributed decision making (DDM) (Schneeweiss, 2003).

Considering the operational reports, it has been observed during a site visit that numerous daily reports are used. The different reports address different KPIs at different aggregation levels. However, to get a complete overview of the performance of a site, the important KPIs should be reported together in aggregation levels fit for decision making; Aggregation levels of the KPIs should correspond with the information needs of the management levels and with the control loops.

Finally, several of the reports require substantial manual labor, prone to human errors. Therefore, producing reports automatically should be considered whenever possible.

6. Conceptual design

The previous Chapter presented a comprehensive analysis of the current state. In this Chapter, the conceptual design of the PMS is presented. First, the desired outline of the PMS will be discussed, presenting all the desired elements of the system. Second, the stakeholders will be presented and their relationships regarding decision making. Finally, the conceptual design process will be presented.

6.1 Performance management system framework

In this section, the desired outline of the PMS is presented, considering the handling of consumer returns for the fashion reseller. Ferreira and Otley (2009) developed a PMS framework that can be used to describe the structure and use of a PMS, introduced in section 4.2. The PMS framework of consists of twelve distinctive, yet interrelated elements and is presented in Figure 6-1. The framework will be used to present the desired outline of the PMS for Ingram Micro Services. Each element of the framework is presented separately in the following sections.

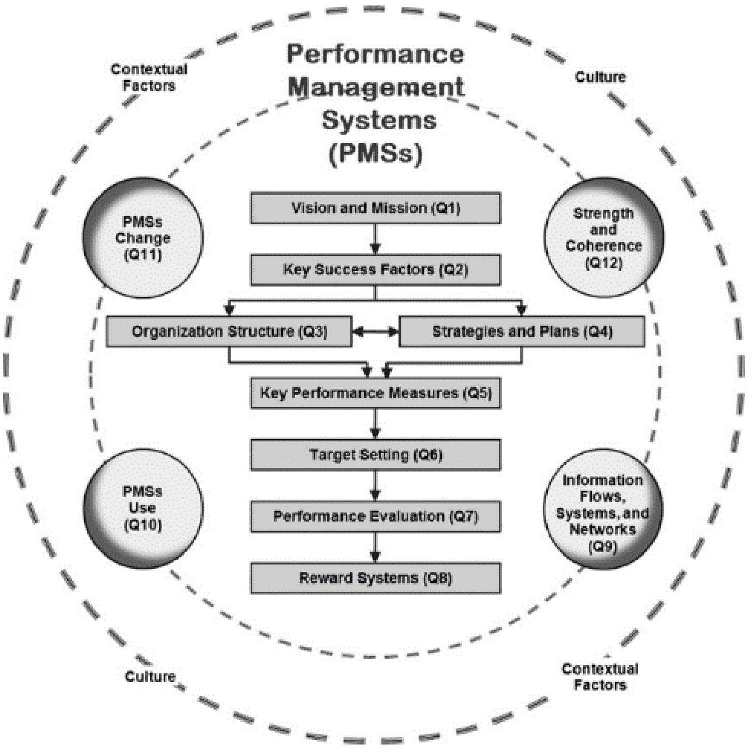

Figure 6-1: Performance management framework (Ferreira and Otley, 2009)

6.1.1 Vision and mission

Ingram Micro Services has as primary goal to be the leading supply chain enabler in the commerce and technology market. It is vital to deliver exceptional experiences to each customer, independent of the type of solution offered. Embracing growth is in the DNA of Ingram Micro Services, where providing robust fulfillment and returns solutions to e-commerce leaders enabled growth for both Ingram Micro Services and their customers. Offering highly scalable and flexible services during intense peaks is part of Ingram Micro Services objective for all customers. Furthermore, focusing on retaining and developing key customers and core solutions by employing continuous improvement, is the way to pursue the goal of leading supply chain enabler. Finally, the communication of the vision and mission throughout the organization is critical. The aims and goals of Ingram Micro Services are communicated through formal means during regular management meetings and presentations.

6.1.2 Key success factors

Key success factors (KSFs) resemble the activities, competencies, capabilities, and attributes of an organization that are essential pre-requisites for its successfulness in an industry at a certain point in time (Sousa de Vasconcellos e Sá & Hambrick, 1989; Thompson Jr. & Strickland III, 2003).

It is vital for Ingram Micro Services to minimize operational costs in order to strive for the position of leading supply chain enabler. Offering low tariffs to customers is essential due to fierce competition in the 3PL business. Because of the revenue model in place for the return handling process, reducing costs is the sole method to improve profitability, which is the first KSF. Previous analysis showed that minimizing operational costs and thus improve profitability can be accomplished by enhancing productivity since there is a direct relationship between productivity and operational costs. Furthermore, offering highly flexible and scalable solutions is regarded as a major important KSF for retaining customers and acquiring new customers. Responding rapidly to desired capacity changes is crucial. Next, as part of the strategy, retaining current customers is essential, and thus, customer satisfaction should also be considered as a KSF. Customer satisfaction can be divided into two underlying factors, quality and lead times. Considering quality first, the fashion reseller is entirely dependent on Ingram Micro Services to deliver the highest attainable level of quality as possible, since the satisfaction of the consumers of the fashion reseller is at risk. Second, lead time is critical due to that items may lose value over time (Blackburn et al., 2004). Finally, increasing employee competence is considered to be a KSF because employee competence directly influences profitability and customer satisfaction.

6.1.3 Organization structure

In scientific research, the relationship between strategy and organizational structure can be seen as bi-directional, where evidence is found supporting the statement that organizational structure needs to determine strategy and vice versa (Ferreira & Otley, 2009).

The organizational structure of Ingram Micro Services requires the design of the PMS to allow for the management of performance on site level and the overall level (all sites). Therefore, in the design of the PMS, different aggregation levels of performance should be incorporated in order to use PMS effectively at multiple levels. Furthermore, comparisons amongst return sites should be a core requirement of the design in order to incorporate benchmarking and induce organizational learning. It is important to keep in mind that the requirements of the PMS per organizational level can differ, and thus, aligning goals and objectives is essential.

6.1.4 Strategies and plans

The strategy of the company is developed by the top management of Ingram Micro Services and is communicated using recurring presentations and meetings throughout the company. The core of the strategy of Ingram Micro Services is growth through focus, where it is more important to be a leader in one core solution, instead of offering all solutions to every customer. To ensure the company's success, delivering quality to the customers is essential. Continuous improvement and innovations are imperative in the pursuit of delivering high quality while minimizing operational costs.

6.1.5 Key performance indicators

KPIs can be defined as the set of performance measures that lead to the achievement of current and future business success (Parmanter, 2007). Therefore, the KPIs used in the PMS should be derived from the company's objectives, KSFs, strategies, and plans. Both financial and non-financial KPIs should be considered since merely using financial criteria is inadequate for assessing and managing performance in the current dynamic business environment (Ittner, Larcker, & Randall, 2003). However, to benchmark against the other sites, financial KPIs need to be considered carefully, due to that revenues and costs differ substantially between return sites.

Furthermore, the aggregation level for each KPI should be determined explicitly. It is essential to present the different management levels in the organization the right KPIs. Furthermore, the KPIs should be presented at an adequate aggregation level to maximize the diffusion of knowledge. At the site level, it is beneficial to present KPIs as detailed as possible to provide the supporting information necessary for decision making. At the overall level it is not desired, nor useful, to present all KPIs in full detail due to information overload. Besides the aggregation level of the KPIs, KPIs related to customer satisfaction need to be considered as eminently important. All KPIs directly related to the satisfaction of the fashion reseller, e.g., SLA24, SLA48 and defect quota, must be incorporated in the PMS.

Finally, the reporting of performance is essential to assess the KPIs adequately. For all return sites, several similar performance reports are used in order to monitor performance at the site level and overall level. Site managers have a good understanding of what KPIs are important to them, which are mostly non-financial KPIs. Furthermore, in an interview with the site manager it became clear that the usefulness of KPIs reported at the overall level was not observed as high. Therefore, it is crucial to have a common understanding of the use and importance of each KPI considering Ingram Micro Services and the fashion reseller.

6.1.6 Target setting

For each KPI a target must be determined, which should be regarded as a critical aspect of performance management (Ittner & Larcker, 2001; Otley, 1999; Stringer, 2007). Every KPI should be accompanied by a target determined centrally by the overall management, where site managers should be involved in the development of targets. Considering the KPIs relevant to the fashion reseller, the fashion reseller should determine all the targets.

In the development of targets, it is essential to be aware of potential differences between sites. Benchmarking against other sites may result in interesting insights that benefit organizational learning. Benchmarking against return handling sites of other customers is not deemed to be a good strategy, due to different revenue models, cost structures and requirements imposed by the other customer.

In the research of Merchant and Manzoni (1989), it was found that in practice it is regarded as desirable when targets tend to be 80 % to 90% achievable, suggesting the development of realistic targets. Finally, due to the dynamic working environment, targets should be reviewed regularly. The research of In ‘t Veld et al. (2010) incorporated the controlling of norms and targets into their control loops, previously discussed in section 4.3.2.

6.1.7 Performance evaluation

The performance should be evaluated based on the KPIs and the determined target. The performance should be analyzed structurally at the site level and overall level. Performance management on the site level requires evaluating individuals, groups of individuals, and their cumulative performance. Performance management on the overall level requires evaluating the performance of the entire site. The aggregation level of KPIs should be determined carefully, to provide the right amount of information for each management level. Besides the appropriate aggregation level, the review period is of great importance. The review period should be determined per KPI in which the management levels play an important role.

Concerning the actual evaluation of performance, performance can be evaluated by subjective and objective evaluation. Subjective evaluations come with ambiguous weighting placed on the various performance dimensions (Ferreira & Otley, 2009). Furthermore, using subjective evaluations enables the possibility to correct for flaws in performance measurement (Gibbs, Merchant, Van-der-Stede, & Vargus, 2004), at the cost of valuable management time and potential bias. On the contrary, objective evaluations leave no room for ambiguous weightings, especially for situations where the input-output relationship is clear (Ferreira & Otley, 2009). Therefore, there should be a greater emphasis on objective evaluations. Finally, the evaluation of performance should support the decision making concerning the process at both the overall and site level.

6.1.8 Reward systems

Ingram Micro Services has a reward system in place where graders are financially rewarded when their performance surpasses the manager's expectations. Overall performance is resembled by the following indicators: productivity, defect quota, sickness, and absence. The reward system is only applied to permanent graders due to the construction of the reward system and employee contracts. It has been observed that the reward system achieves the desired results. Due to the positive results of the current reward system and the lower observed productivity levels of temporary graders, Ingram Micro Services should investigate a way to implement a reward system for temporary graders as well. Though, developing a reward system for temporary graders comes with difficulties related to the labor contracts and is therefore out of the scope of this master thesis.

6.1.9 Information flows, systems and networks

For any performance management system, information flows, systems and networks are essential enabling mechanisms because these function as the binding factor that holds the whole PMS together (Otley, 1999).

The reporting of performance is a component of the information flows. To monitor and evaluate performance, it should be reported in the form of an interactive dashboard, providing the appropriate information for both the site level and overall level. It is desired to enable feedback and feed-forward information flows in order to undertake both corrective and adaptive actions. Furthermore, learning from past experiences aid in the development of preventive actions. Corrective, adaptive and preventive actions should be triggered based on the outcomes of the PMS.

The main difficulty of information flows lies within the systems used to organize data and information. All operational data is stored in either the WMS owned by Ingram Micro Services or by the fashion reseller. The main downside of operating the WMS owned by another party is the lack of open access to the operational data. In the current situation, Ingram Micro Services is entirely dependent on the operational information provided by the fashion reseller, which limits the management of performance

Finally, the IT infrastructure consists of the available networks, which can be used by various parties to share information. Separate networks exist for each WMS, which results in restrictive access to information and complications with the diffusion of information. In the implementation of the PMS, the limited amount of available information and restricted access require careful consideration.

6.1.10 PMSs use

According to Ferreira and Otley (2009), using information and controls is one of the cornerstones of a PMS. Simons (1995) states that PMSs can be used either diagnostically or interactively. Diagnostic control focuses on managing those KPIs which are most important for a company to achieve strategic objectives (Dixon, Nanni, & Vollmann, 1990). Mintzberg (1978) argues that for PMSs to be effective, a proactive role is required in the form of feed-forward information flows. Feed-forward information flows can be used for interactive control, to review strategic assumptions, review current strategies and promote new strategies. For Ingram Micro Services it is desired to use the PMS for both diagnostic control and interactive control. Insights gained from diagnostic control should trigger additional investigations to determine the cause of the performance deviation. Furthermore, the PMS should be used structurally by the site manager as well as by the overall management. In the design of the PMS, it is critical that the desired PMS can be used in order to support the current control loops, described previously in section 5.2.

Finally, the desired PMS should consist of three distinctive levels in order to manage the performance of handling returns for the fashion reseller. The first level considers managing performance of individual graders. The second level considers managing the daily performance of a return site on a local level. The final level, overall level, can be used by the overall management to manage the performance of the different sites. The first two levels concern the support of operational decision making of site managers while the last level of the PMS supports tactical decision making. Utilizing the different PMS levels should be supported by different processes (e.g., control loops) and focusing on specific KSFs. It is critical for the PMS to have the appropriate structure in which performance deviations that cannot be solved locally trigger a responsive action from the overall management.

6.1.11 PMSs change

It is inevitable that environments and organizations change, and so PMSs are required to change too. Change in the PMS applies to both the design infrastructure, e.g., control techniques and KPIs, and the manner of using information concerning performance management (Ferreira & Otley, 2009).

Concerning change dynamics at Ingram Micro Services, the operational WMS at the return site has changed recently. For the return site in question, the change of operational WMS to the WMS of the fashion reseller had a significant impact on the working methods and the management of performance. As was discussed previously, Ingram Micro Services has no direct access to the data stored in the WMS and must rely on performance reports produced by the fashion reseller. Before the change, site managers could monitor the performance in real time for every workstation at the site. After the change, there is a delay time of one day before such information is available. This results in different usages of the PMS at different sites, depending on the operational WMS.

The change of WMS had a significant impact on the number of clarification cases as well, where the daily number of clarification cases increased significantly. The main reason behind this increase is that cases that are now categorized as clarification cases could be processed as normal returns by regular graders with the old WMS.

6.1.12 Strength and coherence

The final element of the framework concerns the strength and coherence of the relations between the elements. In the desired PMS, there should be a high cohesion between all component of the PMS. Despite that components might be well-designed individually, a lack of fit between the components (in either the design or use) can result in deficiencies in performance management (Ferreira, 2002)

6.2 Distributed decision making amongst stakeholders

For the development of the PMS, the stakeholders should be identified because satisfying the expectations of stakeholders is critical. For the returns handling process, there are three main stakeholders: the fashion reseller, the overall management of Ingram Micro Services, and the site management. Each stakeholder has the power to make decisions, and therefore, the stakeholders are considered to be separate decision-making units (DMUs). Each DMU possesses his own information resulting in a strict information asymmetry among the DMUs (Schneeweiss, 2003). Multiple DMUs that affect the return handling process results in distributed decision making (DDM). For DDM, it is essential to understand the nature of the design and coordination of connected decisions, which can be modeled as DDM systems. The book of Schneeweiss (2003) presents the properties of DDM systems for only two stakeholders (DMU), where the more powerful stakeholder is considered to be the top-level and the more dependent stakeholder the base-level. For the return handling process, three separate DDM systems can be developed: fashion reseller – overall management (1), overall management – site management (2) and fashion reseller – site management (3). However, the three DDM systems are highly interrelated and together influence the return handling process. Therefore, the three separate DDM systems should be merged into one DDM system.

In addition to the theory of Schneeweiss, a mid-level is introduced in the DDM system for this master thesis. The mid-level represents the stakeholder that both functions as the top-level and the base-level, dependent on the respective stakeholders. The fashion reseller is considered as the top-level, the overall management as the mid-level and the site management as the base-level. The top-level has an influence on the decisions made by the mid-level and base-level by posing instructions. Furthermore, the mid-level has an influence on the decisions made by the base-level by posing instructions as well. It can be argued that surpassing a management level is unconventional. However, the fashion reseller instructs the site management directly concerning the quality management. The DDM system of the return handing process has been visualized in Figure 6-2.

Before an instruction is given by the top-level (mid-level) to one of the subordinate levels, the top level (mid-level) takes the possible reaction of the subordinate level into account, referred to as anticipation. An example of anticipation of the fashion reseller is that in cases of forecast errors larger than +10%. All return orders that surpass the limit need are not subject to the SLAs and may be processed at a later time. Together, all levels determine a decision to be implemented which influences the return handling process of a site, or sites. The results of an imposed decision should be observed and reported back to both the top-level, mid-level and base-level by the PMS.

The DDM system in itself can be considered as a control loop, where the anticipation of the subordinate level functions as a feedforward loop and the feedback loop is observed for reporting the results of implementations back to the top-level, mid-level and base-level.

Finally, it is vital during the development of the PMS to incorporate the DDM system for goal congruence and goal alignment. It is critical to understand that for the return handling process, not a strict top-down management structure is employed, but a management structure where the decision power is distributed amongst the DMUs. There is a close partnership between Ingram Micro Services and the fashion reseller. Concluding, all stakeholders are mutually dependent on ensuring both the short and long-term success of the return handling process.

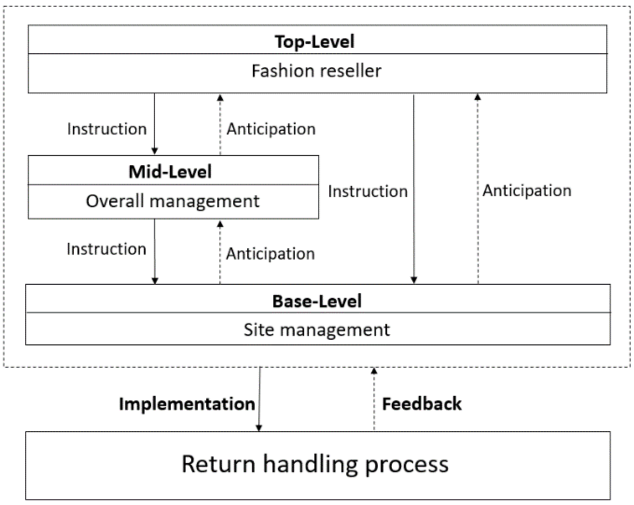

Figure 6-2: DDM system at Ingram Micro Services

6.3 Conceptual design for the performance management system levels

In this section, the conceptual design for the different levels of the PMS will be presented. The desired outline of the PMS framework was already discussed in section 6.1. Based on the desired PMS framework, five elements of the framework are selected to be designed in more detail: KPIs, target setting, performance evaluation, information flows, systems and networks, and PMSs use.

For the conceptual design for those five PMS elements, the design process developed by Leinonen (in Mettänen, 2005) will be used, depicted in Figure 6-3. The design process will be used to provide structure in designing the different levels within the PMS. The model of Leinonen was selected for three distinctive reasons. First, Mettänen (2005) proposed that the model of Leinonen is a combination of the advantages of many different models (e.g., see Kaplan & Norton, 1996; Kaydon, 1999). Second, the design process shares a great deal of similarity with the PMS framework of Ferreira and Otley (2009), which ensures the alignment of the desired outline of the PMS framework and conceptual design. Finally, the model was successfully applied in designing an operational and tactical PMS in the research of Van Eijsden (2016).

Leinonen's model consists of seven stages: Clarifying vision and strategy (1), describing processes (2), recognizing success factors (3), defining measures (4), pushing measures down from top management to lower levels (5), defining reporting principles (6), and how to collect data and show results (7). Each stage is discussed in more detail in the following sections.

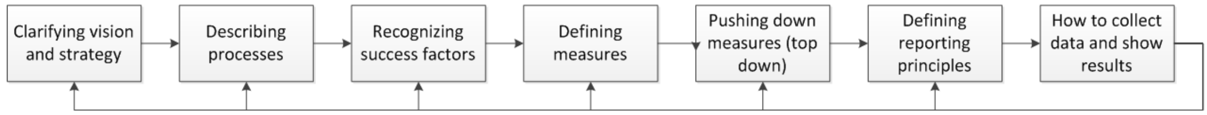

Figure 6-3: Leinonen's model (in Mettänen, 2005)

The model of Leinonen is a generic framework, but it has the potential to incorporate specific characteristics (processes and KSFs) in the design process. This is especially important for Ingram Micro Services due to the different levels in the PMS are supported by different processes and focus of different KSFs. Therefore, the same design process can be used to develop unique designs for the different PMS levels. Finally, due to the generic nature of the model, the design process could be used for other customers of Ingram Micro Services as well.

6.3.1 Clarifying the vision and the strategy

In the first stage, the mission and the strategy of Ingram Micro Services must be defined. In section 6.1.2 it was stressed that the vision and company strategy should be evident throughout the organization in order to support the different levels of the PMS. Therefore, clarifying the vision and strategy forms the foundation of the design. Furthermore, the vision and company strategy define the future business direction. For that reason, those should be clarified together with their potential implications for the different business units within Ingram Micro Services.

6.3.2 Describing the processes

Processes can be described as the implementation of strategic targets (Franceschini, Galetto, & Maisano, 2007). It is key to distinguish the processes that will be managed by the PMS, especially the supporting processes presented in the form of control loops (section 5.2). Furthermore, analyzing the sub-processes supports the identification of process elements that influence success factors. Using observations, interviews, process analysis, and control loops, vital process elements can be distinguished.

It should be noted that the stage describing the processes is not an equivalent of the analysis of the current state. Describing the processes focuses on linking specific process elements to the PMS levels while the current state analysis described the current setting of the return handling process in general.

6.3.3 Recognizing the success factors

As was stated in section 6.1.2, KSFs resemble the activities, competencies, capabilities, and attributes of an organization that are essential pre-requisites for its successfulness in an industry at a certain point in time (Sousa de Vasconcellos e Sá & Hambrick, 1989; Thompson Jr. & Strickland III, 2003). It is essential to execute all activities related to KSFs at the highest attainable level possible. Mahmood and Sajid (2012) stated that KSFs have strong ties with strategic objectives, thus forming the bridge between strategy and processes. By identifying KSFs, appropriate KPIs can be defined. For each level of the PMS, the relevant KSFs must be identified since not every KSF is related to each PMS level.

6.3.4 Defining the measures

In this stage, the KPIs used in the PMS will be defined for each level. The KPIs should be derived from the KSFs, and thus, from the company's objectives, strategies, and plans. Furthermore, the analysis of the current state, interviews and academic literature will be used in defining the KPIs. To structure the development of the KPIs, the modified performance measure record sheet (Neely et al., 1997) will be used, presented in Appendix D.

6.3.5 Getting measures down from top management to the lower levels

This stage of the model of Leinonen focusses on the propagation of the KPIs to all stakeholders (DMUs). In the design model, a strictly hierarchical approach is intended by Leinonen to push down the important measures from top management to all lower levels. However, given the distributed decision-making structure for the return handling process, a strictly hierarchical approach for the diffusion of the KPIs is not deemed as appropriate. To ensure goal congruence amongst all DMUs, the propagation of the KPIs and the DDM structure should already be integrated into the design of the KPIs for the different PMS levels.

6.3.6 Defining the reporting principles

Defining reporting principles considers the practical aspect of reporting, e.g., how often to measure, how often to report, the review period of each measure and the source of data for each measure. Four questions of the measure record sheet are dedicated to reporting principles (Appendix D). Furthermore, the tradeoff between data accessibility, retrieval costs and usefulness should be examined carefully. Incorporating IT experts, WMS owners, and data engineers already during the design of the PMS is deemed as beneficial to examine the possibilities and potential drawbacks for reporting certain measures.

6.3.7 Determining how to collect the data and how to report the results

The final phase of Leinonen's model (in Mettänen, 2005) focusses on the infrastructure of collecting and reporting data. Mettänen (2005) stresses to make use of already existing tools in the organization to reduce handling times and additional implementation costs. Furthermore, automated data collections should be explored to reduce the number of errors and time spent creating the reports. Concerning the reporting of the performance, different options should be considered. The options range from basic excel sheets and applications, to complete systems automatically recording data and producing the designed reports. The final stage serves already as a link toward the implementation phase of the PMS model.

7. Detailed design

In this Chapter, the conceptual design approach, developed in the previous Chapter, has been applied to the three levels of the PMS. The last three stages of the design process of Leinonen (in Mettänen, 2005) will not be addressed separately. Those stages are already included in the design of each KPI, due to the use of the modified performance measure record sheet. Table 3 presents the indices, parameters, and variables used for the detailed design of the PMS levels. Each level of the PMS has been designed individually. To finalize the Chapter, the different levels of the PMS will be validated.

	Notation	Definition
Indices	i	Individual grader
	h	Hour
	s	Shift
	t	Day
	w	Week
	m	Month
	p	Productivity group
	ws	Workstation
Parameters	G_i	Set of individual graders with i = 1,…,g
	PG_p	Set of individual graders i belonging to productivity group p, with p=low, high, all ($PG_{all} = G$)
	W_{ws}	Set of workstations with ws=1,…,94
	SH_s	Set of hours allocated to shifts with s=1,2
	WD_w	Set of days in a week with w=1,…,53
	M_m	Set of days in a month with m=1,...,12
	$PI_{i,h,t}$	Processed items by grader i during hour h on day t, with h=6,…,23
	$PO_{i,h,t}$	Processed orders by grader i during hour h on day t, with h=6,…,23
	$DI_{i,h,t}$	Items classified as defective by grader i during hour h on day t
	$CI_{i,h,t}$	items classified as clarification case by grader i during hour h
	OH_{max}	Latest operating hour
	$GH_{i,h,t}$	Binary variable, 1 if grader i worked during hour h on day t, 0 otherwise
	$S_{i,s,t}$	Binary variable, 1 if grader i is sick during shift s on day t, 0 otherwise
	$BS_{i,s,t}$	Binary variable, 1 if grader i is present on day t when t-1 the grader was sick, 0 otherwise
	$A_{i,s,t}$	Binary variable, 1 if grader i is absent during shift s on day t, 0 otherwise
	$BA_{i,s,t}$	Binary variable, 1 if grader i is present on day t when t-1 the grader was absent, 0 otherwise
Variable	$PS_{p,s,t}$	Productivity level of productivity group p during shift s on day t
	$PO_{p,w}$	Productivity level of productivity group p during week w

	$DQI_{i,h,t}$	Defect quota of individual grader i during hour h on day t
	DQS_t	Defect quota of the site on day t
	DQO_w	Defect quota of the site during week w
	$CCR_{i,h,t}$	Clarification cases rate of grader i during hour h on day t
	$VSA_{i,m}$	Voluntary sickness absence of grader i in month m
	$IVSA_{i,m}$	Involuntary sickness absence of grader i in month m
	$Sickness_{s,t}$	Sickness rate during shift s on day t
	$Sickness_w$	Sickness rate during week w
	$VA_{i,m}$	Voluntary absence of grader i in month m
	$IVA_{i,m}$	Involuntary absence of grader i in month m
	$Absence_{s,t}$	Absence rate during shift s on day t
	$Absence_w$	Absence rate during week w
	PAT_w	Percentage of graders working above the desired productivity level in week w
	CU_w	Capacity utilization in week w
	$SLA24_t$	SLA score for SLA24 on day t
	$SLA48_t$	SLA score for SLA48 on day t
	SLA_t	SLA points obtained on day t
	$CSLA_m$	Cumulative SLA points in month m

Table 3: Definitions of indices, parameters, and variables

7.1 Design of the individual

In this section, the individual level of the PMS is designed. First, the vision and strategy are discussed. Next, the processes subject to the individual level of the PMS are discussed, followed by the relevant KSFs for this PMS level. Finally, the KPIs are developed. It is important to understand that in the design phase, the limitations due to a specific WMS in place are not considered since the goal of this master thesis is to find the optimal level of detail of a PMS. The performance management of individual graders can be divided into two approaches. The first considers the daily performance of individual graders and the second considers the performance of individual graders over time. The two different approaches will both be incorporated in the individual level of the PMS.

7.1.1 Clarify vision and strategy

In section 6.1.1 and 6.1.4, the vision and strategy of Ingram Micro Services were discussed extensively. The goal of Ingram Micro Services is to be the leading supply chain enabler in the commerce and technology market. It is vital to deliver exceptional experiences to every customer independent of the type of solution offered. As part of the strategy, continuous improvement is of great importance to the organization. Furthermore, due to the 3PL environment, reducing costs is paramount

7.1.2 Describing the processes

The complete return handling process was explicitly described in section 5.1.1. Though, it is essential to understand that the individual level of the PMS focusses on how to manage both the daily performance of individual graders and individual performance over time. In section 5.2, it has been observed that the daily individual performance of graders is managed by three separate control loops:

Productivity control, quality control, and clarification control. Furthermore, section 5.2 presented the workforce management control loop, focusing on individual performance over time is.

7.1.3 Key success factors

In section 6.1.2, all KSFs for Ingram Micro Services have been presented. However, for the individual level of the PMS, not all KSFs are of interest. Given the processes subject to the individual performance of graders, only three KSFs are considered: Improve profitability, customer satisfaction and increase employee competence.

7.1.4 Designing key performance indicators

The KPIs that will be incorporated in this PMS level are designed based on analysis of the current state (e.g., control loops), the KSFs, and scientific literature. Table 4 presents all the relevant KSFs with corresponding KPIs for the individual level of the PMS. Note, sickness and absence cannot be directly linked to a specific KSF, but are as important as the other KPIs. In the following section, each KPI will be elaborated and designed individually.

Key success factor	Key performance indicator
Improve profitability, Increase employee competence	Individual productivity
Customer satisfaction, Increase employee competence	Defect quota
Increase employee competence	Clarification cases rate
-	Sickness
-	Absence

Table 4: Overview KPIs individual level

7.1.5 Daily individual performance

For monitoring the daily performance of individual graders, the KPIs productivity, defect quota, and clarification cases rate are considered.

Individual productivity

In the financial analysis, section 5.1.5, productivity came forth as the variable that represents the most significant part of the revenue, as well as the more significant part of the costs. Additionally, the manager of continuous improvement stressed the fundamental importance of productivity as a KPI. Individual productivity is one of the determinants for individual performance, a key variable for the workforce control loop. Furthermore, individual productivity is used by Ingram Micro Services to manage and improve the competence of graders, which is also a KSF for this PMS level.

The individual productivity is measured each hour automatically. The frequency of review, however, should be considered more carefully. Two main options prevail to review individual performance. The first option is hourly reviewing and the second option is daily reviewing (similar to reviewing per shift). The main benefit of reviewing per hour is that changes in productivity levels can be detected immediately and thus, interventions can be enforced promptly. However, the main drawback of reviewing productivity hourly is that it requires significant managerial efforts (time). Additionally, when reviewing the productivity hourly, a lower productivity level in one hour cannot be compensated with higher productivity level in another hour, which may be likely due to the diversity of return items.

Reviewing per shift requires lower managerial effort and allows for compensation. However, prompt inventions are not possible with reviewing productivity per shift. Therefore, individual productivity should be reviewed each hour. Appendix E presents the proposed guidelines to review individual productivity hourly. The formula to determine individual productivity determined for all graders, hours and days is presented in equation 7.1.

$$PI_{i,h,t} = processed\ items\ per\ hour = PI_{i,h,t}, \forall i, h, t, \qquad (7.1)$$

The target for $PI_{i,h,t}$ is set at 100 UPH, companywide. Targets should be set at a level that can be achieved by 80% to 90% of the workforce (Merchant & Manzoni, 1989). In the analysis, it was discovered that only a minimal group of graders are able to reach the target. Therefore, the target should be reconsidered by Ingram Micro Services.

The owner of the operational WMS is responsible for measuring the this KPI. Data on productivity is measured automatically since the return handling process is performed using a specially designed WMS, registering all grading activities of graders in a data warehouse. Although the source of the data is the WMS, the daily productivity report presents the measurements. Additional BI-tools are required to transform WMS data into interpretable reports. Finally, it is the role of the site manager and shift leaders to monitor, assess and improve the productivity levels. The decisions made based on this data were already proposed in section 5.2.2.

Individual defect quota

Delivering high-quality goods that the fashion reseller can sell directly to their consumers is part of the KSFs of Ingram Micro Services. For that reason, the second KPI included in this PMS level is the defect quota. In the literature, the quality of delivered goods (Gunasekaran, Patel, & Tirtiroglu, 2001) or diagnosis accuracy (Lambert et al., 2011)(similar to the defect quota) are introduced as essential performance measures in supply chain management and reverse logistics. Furthermore, the individual defect quota is used by Ingram Micro Services to manage and improve the competence of graders, which is also a KSF for this PMS level.

For this KPI, the same methodology concerning the measurement and review period should be implemented as for the first KPI. The measurement frequency and the review period are therefore set at hourly. Appendix E presents the analysis and guidelines for hourly reviewing the individual defect quota. The formula to determine individual defect quota for all graders, hours and days is presented in equation 7.2.

$$DQI_{i,h,t} = \frac{Defective\ items\ (i,h,t)}{Processed\ items\ (i,h,t)} = \frac{DI_{i,h,t}}{PI_{i,h,t}}, * 100\%, \forall i, h, t \qquad (7.2)$$

Concerning the target level of $DQI_{i,h,t}$, it was noted during interviews that the applied target can differ weekly. This can be justified due to the sinusoidal pattern of the defect quota over time, observed in Figures 5-13 and 5-18. The target should be set between 4-6%, following from analyzing the feedback from the fashion reseller on past performance. When alternative targets are applied, this should be notified in the reports to adequately assess $DQI_{i,h,t}$. Furthermore, the WMS owner is responsible for measuring the data and functions as the source of the data as well. The site manager and shift leaders are the owners of the measures and acts upon the results. Actions based on the results of this KPI were described in section 5.2.5.

Individual clarification cases rate

For the fashion reseller, clarification cases should be solved as fast as possible since their consumers have to wait for their refund until the case is processed by the clarification team. When a grader reports an item as a clarification case accidentally, this decision cannot be reversed, while the items count as a processed item for the grader. Therefore, it is for Ingram Micro Services important to monitor the clarification cases rate to detect misuse. For the KPI clarification cases rate, the same methodology concerning the measurement, and review period should be implemented as was determined for the previous two KPIs. Appendix E presents the analysis and guidelines for the review period hourly. Equation 7.3 presents the formula to determine the individual clarification cases rate for all grader, hours and days.

$$CCR_{i,h,t} = \frac{Clarification\ cases\ (i,h,t)}{Processed\ items\ (i,h,t)} = \frac{CI_{i,h,t}}{PI_{i,h,t}} * 100\%, \forall i, h, t \qquad (7.3)$$

Concerning the target level of $CCR_{i,h,t}$, it is difficult to determine a specific value, since there is only limited data available. A proper proxy for the target is the average $CCR_{i,h,t}$, equal to 5%. The owner of the WMS is responsible for measuring the data, where the WMS functions as the data source as well. The site manager and the shift leaders are the owners of the measure. Since the change to the WMS of the fashion reseller, clarification cases became more problematic. Unfortunately, Ingram Micro Services is not directly able to alter the WMS of the fashion reseller. Therefore, a close collaboration is required to improve the clarification cases rate, especially because clarification cases should not be problematic given the past performance.

7.1.6 Individual performance over time

Monitoring individual performance over time is the second function of the individual level of the PMS. To assess the general performance of a grader, the workforce control loop showed that besides the KPIs productivity and defect quota, sickness and absence are determinants for the general performance of individuals.

Monitoring both sickness and absence is necessary since those KPIs reflect important constructs such burnout and motivation (Bakker et al., 2003; Schaufeli et al.,2009). Especially, motivation is considered an essential factor for all the aspects of individual performance, based on an interview with the site manager. The site manager noted that motivation is a strong determinant for the KPIs productivity and defect quota.

In the literature, sickness is referred to as sickness absenteeism. Sickness absenteeism is considered to be very complex and can be influenced by a combination of social, organizational, and personal factors (Dekkers-Sanchez, Hoving, Sluiter, & Frings-Dresen, 2008). Johns (1997) assumed two explanations for the decision to reporting oneself sick. One explanation proposed is the desire to withdraw from poor work circumstances, agreeing with the notion of voluntary sickness absenteeism (Chadwick-Jones, Nicholson, & Brown, 1982). A second explanation is that sickness can be influenced by distress due to high job demands; absenteeism used to cope with stressful job demands (Kristensen, 1991). The second explanation agrees with the notion of involuntary sickness absenteeism due to the inability to perform the work (Chadwick-Jones et al., 1982). In the research of Bakker et al. (2003), absenteeism was identically analyzed as (in)voluntary sickness absenteeism, with similar reasoning.

In the article by Schaufeli et al. (2009), sickness absenteeism (voluntary and involuntary) was investigated thoroughly using the Job Demands and Resources (JD-R) model (Demerouti et al., 2001). A similar approach was used in the study of Bakket et al. (2003), studying absenteeism (voluntary and involuntary). Both studies found that the construct burnout indirectly predicts involuntary (sickness) absenteeism. Schaufeli et al. (2009) showed that work engagement predicts voluntary absenteeism and Bakker et al. (2003) showed that organizational commitment (e.g., motivation) predicts voluntary sickness absenteeism.

For the four KPI resembling sickness and absence of individuals, operational definitions developed by Steel (2003) have been used. It is required to measure whether employees are either sick or absent each shift since different graders work each shift. The four KPIs need to be reviewed every month to analyze whether there is an imbalance in job demands and job resources. Based on the operational definitions, formulas were developed for the KPIs, presented in equation 7.4-7.7, applicable for all graders in each month.

$$VA_{i,m} = Number\ of\ times\ of absence\ per\ month = \sum_{t \in M_m} \sum_{s \in S} BA_{i,s,t}\,, \forall i, m \tag{7.4}$$

$$IVA_{i,m} = Number\ of\ days\ of\ absence\ per\ month = \sum_{t \in M_m} \sum_{s \in S} A_{i,s,t}\,, \forall i, m \tag{7.5}$$

$$VSA_{i,m} = Number\ of\ times\ of sickness\ per\ month = \sum_{t \in M_m} \sum_{s \in S} BS_{i,s,t}, \forall i, m \tag{7.6}$$

$$IVSA_{i,m} = Number\ of\ days\ of sickness\ per\ month = \sum_{t \in M_m} \sum_{s \in S} S_{i,s,t}\,, \forall i, m \tag{7.7}$$

There are no targets for the four KPIs. Subjective input is required from the site managers to assess the four KPIs. The site manager and shift leaders are together responsible for the measurements, requiring the registration of all sick and absent graders per shift per day ($A_{i,s,t}$ and $S_{i,s,t}$), resulting in significant manual work since not all graders report themselves sick or absent. Subsequently, the site manager and the shift leader are responsible for improving the KPIs for individuals. It is fundamental to manage these KPIs since employee wellbeing is dependent on it (Bakker et al., 2003; Demerouti et al., 2001). Personal contact between management and employees is essential to see where Ingram Micro Services can assist their employees in any way to improve their wellbeing.

7.2 Design of the site level

The site level of the PMS focuses on managing the performance of the site from the site management's point of view. In the previous section, the level of the PMS for managing individual performance was presented, which focuses entirely on individual graders. The performance of a site can be regarded as the cumulative performance of all individual graders. It should be noted that the first stage of Leinonen's model (in Mettänen, 2005) was already presented for all levels of the PMS in section 7.1.1 and will therefore not presented again.

7.2.1 Describing the processes

The main underlying process has been described extensively in section 5.1.1. Though, it is essential to understand that the site level of the PMS focusses on how to manage the daily performance of the site. Using the control loops shift control and quality control, the site's performance can be managed. Furthermore, the site's performance needs to be reviewed daily to support the development of the workforce planning. Finally, the fashion reseller is foremost interested in the performance on site level and not on the individual level, providing additional motivation for the design of this PMS level.

7.2.2 Key success factors

In section 6.1.2, all KSFs for Ingram Micro Services have been presented. However, for the site level of the PMS, not all KSFs are of interest. Given the processes subject to the performance of the site, only three KSFs are considered: Improve profitability, customer satisfaction and increase employee competence.

7.2.3 Designing key performance indicators

The KPIs that will be incorporated in this PMS level are designed based on the current state analysis, the relevant KSFs, and scientific literature. Table 5 presents all the relevant KSFs with their corresponding KPIs. Each KPI will be elaborated and designed individually in the subsequent sections.

Key success factor	Key performance indicator
Improve profitability, Increase employee competence	Productivity
Customer satisfaction, Increase employee competence	Defect quota
	Product and packing quality
	SLA24, SLA48
-	Sickness
-	Absence

Table 5: Overview KPIs site level

Productivity

Although the productivity of individual graders is controlled in the previously discussed PMS level, the productivity level of the site provides a good overview of the general performance of a site and reflects the productivity level of the employed workforce pool. Figures 5-9 and 5-10 in section 5.1.6, showed that two productivity groups are present within the workforce pool. Therefore, the productivity level of a site should be presented for the high and low productivity groups in order to monitor developments within the productivity groups.

The hourly measurements for individual productivity can be used to compute the productivity levels for the productivity group. The frequency of review is twice a day to monitor for each shift whether the site 's productivity level differs from expectations. Equation 7.8 presents the formula to determine the productivity level for the two productivity groups and the weighted average of both groups per shift per day.

$$PS_{p,s,t} = \frac{Processed\ items\ (p,s,t)}{Grading\ hours\ (p,s,t)} = \frac{\sum_{h \in SH_s} \sum_{i \in PG_p} PI_{i,h,t}}{\sum_{h \in SH_s} \sum_{i \in PG_p} GH_{i,h,t}}, \forall p,s,t \tag{7.8}$$

Since the cumulative productivity level is the weighted sum of individual productivity, similar targets should be considered, 100 UPH. The measurer, the owner, the source and the actor related to the measure are similar to the productivity KPI presented in section 7.1.4. The decisions made on the data, however, are different. Based on the site productivity, the shift control loop is deployed. Furthermore, the development of the workforce planning utilizes the results of this KPI. Finally, a reward structure for temporary graders can be implemented to stimulate the achieving of higher productivity levels.

On a final note, the time lost due to breaks and shift changes has not been incorporated in the formula for the sake of simplicity. For validating this KPI however, break times and shift changes have been considered.

Defect quota

The defect quota of returns is one of the main KPIs of real importance to the fashion reseller. The fashion reseller is interested in the defect quota of a site and not in the defect quotas of individual graders. The defect quota of a site is the cumulative defect quota of all individual graders on a day. Therefore, the gathered data for the individual defect quotas per hour can be used to determine the site’s defect quota. The review period should be daily since the fashion reseller is interested in the daily defect quota. Equation 7.9 presents the formula to determine the daily defect quota of a site for any given day.

$$DQS_t = \frac{Defect\ items\ (t)}{Processed\ items\ (t)} = \frac{\sum_{h \leq OH_{max}} \sum_{i \in G} DI_{i,h,t}}{\sum_{h \leq OH_{max}} \sum_{i \in G} PI_{i,h,t}}, \forall t \tag{7.9}$$

The target level of DQS_t should be within the range 4-6%, similar to the target level of $DQI_{i,h,t}$. Though, target levels may differentiate over time, due to the observed sinusoidal pattern in Figures 5-13 and 5-18. Furthermore, the WMS owner is responsible for measuring the data and functions as the source of the data as well. The site manager and shift leaders are the owners of the measures and acts upon the results. Actions should be initiated when the site’s defect quota is too high. Actions may include additional quality checks and the shift of focus from improving productivity to quality.

Product and packing quality

Besides the defect quota, the product and packing quality are essential for the KSF customer satisfaction, since those two quality measures indicate whether graders do their job adequately. Equations 7.10 and 7.11 present the formulas to determine the product and packing quality, respectively.

$$Product\ quality_t = \frac{Product\ errors_t}{Sample\ size_t} * 100\%, \forall \text{t} \tag{7.10}$$

$$\text{Packing}\ quality_t = \frac{Packing\ errors_t}{Sample\ size_t} * 100\%, \forall \text{t} \tag{7.11}$$

Ingram Micro Services measures and reviews the product and packing quality each day by randomly sampling graded items. The target for both KPIs is 4%. All the measurements are done before the return items are shipped back to the fashion reseller, thus, allowing to intervene directly. The site manager and shift leaders are responsible for acting on both measures. Based on the quality checks, individual graders can be confronted and educated on what went wrong. Additional training may be required to enhance the knowledge of graders as well.

Service level agreements

Strict agreements are made considering the maximum allowed processing time because the consumers of the fashion reseller await their refund until their return order is processed at one of the return sites. Gunasekaran et al. (2001) included both customer satisfaction and order lead time in the list of performance measures important for supply chain management. Furthermore, Shaik and Abdul-Kader (2012) included reverse logistic cycle time as a KPI in their balanced scorecard appropriate for reverse logistic enterprises.

The agreements propose that 80% of all return orders should be processed within 24 hours and 100% should be processed within 48 hours. In order to deliver exceptional experiences to the customer, it is key to manage the KPIs regarding the SLA processing time: SLA28 and SLA48.

It should be noted that SLA24 and SLA48 are calculated on order level and not on item level. Table 6 introduces additional notation for the design of these KPIs. Equations 7.14 and 7.15 present the formulas to determine SLA24 and SLA48, where equations 7.12 and 7.13 are additionally required to determine the KPIs.

Variables	Definition
$\boldsymbol{F_t}$	Short forecast on day t
$\boldsymbol{F10_t}$	Upper bound forecast on day t which is 10% larger than $F(t)$
$\boldsymbol{Ibn_t}$	Actual inbound on day t
$\boldsymbol{Icut_t}$	Ending inventory on day t
$\boldsymbol{I_{24-48,t}}$	Amount of inventory which spends already more than 24 hours at the return site but less than 48 hours on day t
$\boldsymbol{I_{48,t}}$	Amount of inventory which spends more than 48 hours at the return site on day t
$\boldsymbol{P_t}$	Processed orders on day t
$\boldsymbol{DI_t}$	Expected processing time (in days) of $Icut(t)$ on day t, $DI(t) = \frac{Icut_t}{\frac{1}{5}\sum_{i=1}^{5} P_{t-i}}$

Table 6: Variables SLA calculations

$$SLA\ qty_t = \begin{cases} \min\{F10_t, Inb_t\}, I_{24-48,t} + I_{48,t} > 0 \ and \ F_{10}(t) > 0 \\ \min\{F_{10,t}, I_{24-48,t} + I_{48,t}\}, I_{24-48,t} + I_{48,t} > 0 \ and \ F10_t = 0 \\ \min\{F10_t, Yesterday_t, Icut_t\}, I_{24-48,t} + I_{48,t} = 0 \end{cases}, \forall t \tag{7.12}$$

$$Yesterday_t = \begin{cases} \max\{Inb_{t-1} - F10_{t-1} + F_t, Inb_t\}, Inb_{t-1} > F_{10,t-1} \\ Inb_t, Otherwise \end{cases}, \forall t \tag{7.13}$$

$$SLA24_t = \begin{cases} 1, I_{24-48,t+1} = 0 \\ \min\left\{1, \frac{P_{t+1}}{SLA\ qty_t}\right\}, Otherwise \end{cases}, \forall t \tag{7.14}$$

$$SLA48_t = \begin{cases} 1, I_{48,t+1} = 0 \\ \min\left\{1, \frac{P_{t+1} + P_{t+2}}{SLA\ qty_t}\right\}, Otherwise \end{cases}, \forall t \tag{7.15}$$

Both KPIs need to be determined and reviewed daily since the scores are assessed every day by the fashion reseller. The SLA scores are determined both by the fashion reseller and Ingram Micro Services for verification purposes. The SLA scores are based on several variables, with each a different source. The forecast is reported to Ingram Micro Services via an excel sheet by the fashion reseller. The actual inbound orders and ending inventory are counted manually by Ingram Micro Services. Finally, the processed orders originate from the operational WMS. The site manager is the owner of the KPIs and should take action when the SLAs are violated too often. Violating the SLAs can easily be overcome by planning additional graders. However, planning additional capacity results in additional direct labor costs as well. Though, the additional labor costs may be insignificant since the penalty of violating the SLAs too often in a month is severe.

Sickness and absence

In the previous level of the PMS, (in)voluntary sickness absenteeism and absenteeism were thoroughly discussed, together with the implications of those variables. It was noted earlier that sickness and absence are not directly related to KSFs. Nevertheless, sickness and absence are key input variables for the development of the workforce planning, influencing operational costs and reaching the SLA targets. Furthermore, the sickness and absence rates of the second shift are required as an input parameter for the control loop shift control. Therefore, sickness and absence should reviewed every shift.

To determine the sickness rate and absence rate per shift, the measurements of $S_{i,s,t}$ and $A_{i,s,t}$ can be used to determine the cumulative rates. Equations 7.16 and 7.17 present the formulas to determine the sickness and absence rates for each shift per day. By summing $S_{i,s,t}$ and $A_{i,s,t}$ over all graders that were working during a shift, the total number of sick and absent graders can be determined. The number of graders working per shift can be determined by summating the number of grading hours utilized during the first hour of that shift ($SH_s[1]$), under the assumption that all graders working in a shift begin at the start of the shift.

$$Sickness_{s,t} = \frac{number\ of\ graders\ sick\ during\ shift\ s\ on\ day\ t}{number\ of\ graders\ working\ during\ shift\ s\ on\ day\ t} = \frac{\sum_{i \in G} S_{i,s,t}}{\sum_{h=SH_s[1]} \sum_{i \in G} GH_{i,h,t}}, \forall\ s,t \qquad (7.16)$$

$$Absence_{s,t} = \frac{number\ of\ graders\ absent\ during\ shift\ s\ on\ day\ t}{nnumber\ of\ graders\ working\ during\ shift\ s\ on\ day\ t} = \frac{\sum_{i \in G} A_{i,s,t}}{\sum_{h=SH_s[1]} \sum_{i \in G} GH_{i,h,t}}, \forall\ s,\mathrm{t} \qquad (7.17)$$

A target for sickness and absence is difficult to determine. According to the site manager, reasonable levels for the KPIs are 3.5% and 6.5%, respectively. No historical data was available to verify the target levels proposed by the site manager. The shift leaders are responsible for the measurements to determine both KPIs. The source of the data is an impediment since not all graders report themselves sick or notify their absence. Measurements utilized in the previous PMS level can be used to determine these two KPIs. The site manager is responsible for controlling both KPIs, although this is very difficult since this is mostly out of control of Ingram Micro Services. Though, Ingram Micro Services uses their full potential to provide healthy working conditions and provide job resources for the graders to execute their work successfully.

7.3 Design of the overall level

The final level of the PMS, the overall level, is developed to support tactical decision making of both the site manager and overall level management. Tactical decision making requires monitoring performance with a timescale of a week at minimum (Flapper et al., 1996). At Ingram Micro Services, a gap exists in reporting performance, since performance is reported either daily or monthly. Reporting performance monthly is considered to be too late for interventions by the overall management. This PMS level is developed to fill the void in reporting performance.

7.3.1 Describing the processes

The underlying process was already described extensively in section 5.1.1. In this section, the tactical management of the returns handling process will be introduced. Despite that for this case study one return site was used, the same return handling process is performed at several other sites in Europe. The performance of each site can be managed locally using the first two levels of the PMS. However, it is interesting to make use of benchmarking amongst return sites to stimulate intra-organizational learning. Furthermore, the overall PMS should aid in identifying general difficulties amongst sites, which site managers are not able or in the position to resolve locally, requiring assistance from the overall management to address the problem.

7.3.2 Key success factors

For the overall level of the PMS, all the KSFs presented in section 6.1.2 should be considered. Therefore, the following KSFs are incorporated into the design of the overall level: Improve profitability, customer satisfaction, increase employee competence and, scalability and flexibility.

7.3.3 Designing key performance indicators

The KPIs that will be incorporated in this PMS level are designed based on the current state analysis, the relevant KSFs, and scientific literature. All KPIs will be elaborated and designed individually in the subsequent sections. Table 7 presents all the KSFs with corresponding KPIs for the overall level of the PMS.

Key success factor	Key performance indicator
Improve profitability, employee competence	Productivity
Customer satisfaction, employee competence	Defect quota
	Product and packing quality
	SLA processing time
Increase employee competence	Percentage of the graders performing below target
Scalability and flexibility	Capacity utilization
-	Sickness
-	Absence

Table 7: Overview KPIs on site level

Productivity

The importance of productivity has been stressed on multiple occasions throughout this master thesis. For the overall management, it is therefore interesting to benchmark the productivity levels of different sites against each other, investigating differences amongst sites. Due to the significant difference between the productivity groups, the productivity KPI for the tactical level is also reported separately for the high and low productivity groups. Reporting both productivity groups allows to monitor developments within the productivity groups over time. Additionally, the weighted average of all graders will be incorporated, reflecting the overall productivity level of the site. In order to support tactical decision making, the productivity of each group should be determined and reviewed each week. Again, the hourly measurements used to determine the productivity levels in the previous PMS levels are applied to determine the overall productivity level of the return site. Equation 7.18 presents the formula to determine the productivity for each productivity group per week.

$$PO_{p,w} = \frac{Processed\ items\ by\ group\ p\ in\ week\ w}{Grading\ hours\ utilized\ by\ group\ p\ in\ week\ w} = \frac{\sum_{t \in WD_w} \sum_{h \leq OH_{max}} \sum_{i \in G} PI_{i,h,t}}{\sum_{t \in WD_w} \sum_{h \leq OH_{max}} \sum_{i \in G} GH_{i,h,t}}, \forall p, w \tag{7.18}$$

The target levels for $PO_{p,w}$ should be equal to the general target for productivity, 100 UPH. Though, it was stated early that the target should be revised by Ingram Micro Services due to its unattainability for many graders. Furthermore, benchmarking this KPI against the results of other sites may lead to a more thorough understanding of productivity levels and why those may differ between sites. As the data source, the measurements from the individual level of the PMS can be used. The owner and actor of the KPI are the site manager and the overall management, respectively. The site manager is responsible for improving individual productivity which should eventually results in improving the overall productivity. The overall management can act on the measure by providing additional monetary support to a site for productivity enhancing projects such as the assistance of the in-house reverse logistics engineer. Furthermore, when structural problems are observed, such as lower productivity levels of groups over a more extended period or at multiple sites, a more structural analysis should be executed in collaboration with the fashion reseller in order to improve this KPI.

On a final note, the time lost due to breaks and shift changes has not been incorporated in the formula for the sake of simplicity. For validating this KPI however, break times, and shift changes have been considered.

Defect quota

including the defect quota in the tactical level of the PMS is primarily motivated due to the significant importance of this KPI to satisfy the customer. To support tactical decision making, the defect quota of a site should be determined and reviewed weekly. Similar to the weekly productivity, the weekly defect quota is the cumulative version of the individual defect quota per hour. Equation 7.19 presents the formula to determine the weekly defect quota of a site.

$$DQO_w = \frac{Defect\ items\ processed\ in\ week\ w}{Processed\ items\ in\ week\ w} = \frac{\sum_{t \in WD_w} \sum_{h \leq OH_{max}} \sum_{i \in G} DI_{i,h,t}}{\sum_{t \in WD_w} \sum_{h \leq OH_{max}} \sum_{i \in G} PI_{i,h,t}}, \forall w \quad (7.19)$$

The target level of DQO_w should be within the range 4-6%, similar to the target level of $DQI_{i,h,t}$ and DQI_t. However, target levels should be reviewed and altered over time, due to the observed sinusoidal pattern in Figures 5-13 and 5-18. The source of the data is the individual level of the PMS, where the individually processed items and defects are measured hourly. Although the site manager and the shift leaders are responsible for the KPI, the overall management should function as an actor for the overall level of the PMS. The overall management can review whether there are differences between defect quotas for the different sites. Furthermore, the overall management can bundle all learning point from the analysis of defect quotas to stimulate operational learning within the organization. Finally, the training program of new graders can be revised and generalized for one or multiple sites when the defect quota is observed as a structural problem amongst return sites, to minimize training time and maximize knowledge diffusion.

Product and packing quality

The second and third KPI reflecting customer satisfaction are product and packing quality. Product and packing quality are managed by the site manager and shift leaders. The overall management benefits of reviewing the product and packing quality for several reasons. First, customer satisfaction can directly be quantified. Second, the effectiveness of the training program can be reviewed. Third, it shows the overall delivered quality level of return handling process amongst graders of a site. Equations 7.20 and 7.21 present the formulas to determine the weekly product and packing quality.

$$Product\ quality_w = \frac{Product\ errors_w}{Sample\ size_w} * 100\%, \forall p, w \quad (7.20)$$

$$\text{Packing}\ quality_w = \frac{Packing\ errors_w}{Sample\ size_w} * 100, \forall p, w \quad (7.21)$$

The target level for both product and packing quality should be 4%, which is a strict target proposed by the fashion reseller. Both the product and packing quality are determined each week by the fashion reseller, in a similar fashion as Ingram Micro Services determined these KPIs daily. The source of the data is the weekly quality feed report provided by the fashion reseller. Similar to the DQO_w, the site manager and the shift leaders are responsible for improving the KPI, but the overall management should be considered as an actor of this KPI as well. By benchmarking the product and packing quality against other sites, differences between sites can be discovered. Based on the overall results the of KPIs, the training program can be optimized and, general actions can be developed in cases of inferior performance.

Percentage of graders performing below target

Currently, it is challenging to find new graders who are suited for processing fashion returns at a high productivity rate. Therefore, it is essential to have an indicator in the PMS which resembles the overall performance of the workforce pool; The percentage of graders performing above the productivity target (PAT). Such an indicator can provide insight to the overall management that given the current workforce pool and the labor market, higher productivity levels cannot be reached. It also signals the size of the group of graders that perform below target. Unfortunately, no better replacements can be found for those employees, making it almost impossible to achieve the desired overall productivity target. The KSF increase employee competence can be monitored by this KPI, where a higher level of the KPI is desirable.

The PAT should be determined and reviewed weekly since the hiring and firing of graders are considered as weekly decisions. Equation 7.22 present the formula to determine the KPI PAT each week. Note, the cardinality of a set is depicted in the equation by the symbol | |.

$$PAT_w = \frac{Number\ of\ high\ productivity\ graders}{Total\ graders} * 100\% = \frac{|PG_{High}|}{|PG_{Total}|} * 100\%, \forall w \tag{7.22}$$

No specific targets can be developed for the KPI PAT. Subjective assessments of the site manager and the overall management are required to draw conclusions based on this KPI. However, the KPI can function as an input parameter for the regression equation presented in section 5.1.6. Given the value of PAT, the expected productivity level can be determined, functioning as a minimum target for the overall productivity level of a site. The site manager is responsible for measuring PAT. All required information can be obtained from the individual level PMS. To operationalize this KPI, the productivity groups should be determined each week. The site manager is also the owner of the measure and should act on the results of the KPI. The measure can be improved by firing low productivity graders, training new graders, and improving individual productivity levels. Finally, the overall management should be considered as an owner of the KPI as well, since local efforts of the site management may not be enough to improve the KPI. Benchmarking the PAT against other sites can provide answers to the question why the productivity targets are not reached at specific sites. When all sites experience similar problems, a more structural approach is required in order to improve the KPI, such as offering higher payments to attract a new pool of potential graders.

Capacity utilization

One of the main promises of Ingram Micro Services is to provide customers with solutions that are highly flexible and scalable. Many customers of Ingram Micro Services have built their growth on the flexibility and scalability offered by Ingram Micro Services. To monitor the scalability and flexibility options, the capacity utilization should be monitored closely to make sure enough capacity is readily available before peaks. Furthermore, Lambert et al. (2011) and, Bhagwat and Sharma (2007) proposed to use capacity utilization as a performance measure in reverse logistics and supply chain management as well.

The capacity utilization should be determined and reviewed weekly, due to that the planning is developed weekly, graders can be trained weekly, and capacity requirements may change weekly.

Equation 7.23 present the formula to determine the capacity utilization for a given week. The total available capacity for a week is the number of items that can be processed given the number of workstations, the size of the workforce pool, the average productivity, the hours per shift and the number of workings days of the week.

$$CU_w = \frac{Processed\ items(w)}{min(Workstations * \text{shifts}, workforce\ pool) * productivity * \text{ hours shift} * days\ in\ week} = \frac{\sum_{t \in WD_w} \sum_{h \leq OH_{max}} \sum_{i \in G} PI_{i,h,t}}{min(|W_{ws}| * \text{shifts}, |G|) * PO_{w,all} * \text{hours shift} * |WD_w|}, \forall w \quad (7.23)$$

A specific target for capacity utilization is difficult to define. However, a utilization rate close to 1 should be avoided due to the increased probability of backlog orders. The site manager is responsible for determining the capacity utilization per week because the overall management does not possess all the required information. Three main sources of data are required, where the operational WMS includes the information concerning the processed items by individual graders per hour. The site manager possesses the information concerning the number of workstations, the workforce pool, the number of shifts, the hours per shift and the number of working days in a week. Finally, the average productivity can be determined based on the site level of the PMS. The KPI capacity utilization has two owners, namely, the overall management and the site manager. The site manager has the capabilities to increase the workforce pool and improve productivity. Furthermore, the site manager can organize lateral transshipment to other return sites when the capacity utilization is too close to 1. However, the site manager is not able to add workstations unaccompanied, due to requiring substantial financial support.

Finally, this KPI can be used to control congestion in the supply chain of the fashion reseller, by organizing the direct shipments of batches of return orders to return centers with lower capacity utilization levels. Nevertheless, shipping costs and other processing costs of the different returns sites should be examined carefully.

Service level agreements

In the previous PMS level, SLA24 and SLA48 were discussed. Controlling the processing time is of crucial importance to satisfy the fashion reseller. Additionally, controlling the processing time averts the possibility for substantial penalties. To observe the processing time over time, the SLA scores are translated to SLA points, presented in equation 7.24. Equation 7.25 presents the formula to determine the cumulative SLA points for a month.

$$SLA_t = \begin{cases} -2, SLA24_t < 0.80\ and\ SLA48_t < 1 \\ -1, SLA24_t < 0.80\ and\ SLA48_t = 1 \\ 1, Inb_t < 0.8 * F_t\ and\ DI_t < 1 \\ 0, Otherwise \end{cases}, \forall t \quad (7.24)$$

$$CSLA_m = \sum_{t \in M_m} SLA_t, \forall m \quad (7.25)$$

SLA points are awarded daily, requiring daily measurements. Though, additional measurements are not required since the SLA points for a day can directly be obtained from KPIs SLA24 and SLA48. The cumulative SLA points should be reviewed weekly. In total, the cumulative SLA points in a month may not be more than -4 points. The site manager is directly responsible for improving the KPI since the SLA point are directly related to the SLA24 and SLA48. Again, the scores can be improved by either improving the productivity of the graders or utilizing more grading hours. However, during a month, this KPI cannot directly be improved by Ingram Micro Services since receiving a positive SLA point is also dependent on the daily forecasting accuracy.

Furthermore, in section 5.1.8 it was observed that positive SLA points are obtained regularly, suggesting a forecast error of -20% or more. Substantial forecasting errors often negatively influence a companies' operational performance, particularly delivery performance and costs (Enns, 2002; Vollman, Berry, & Wybark, 1992). Danese and Kalchschmidt (2011) stated that improving forecasting accuracy can have a beneficial effect on operational performance. Therefore, the fashion reseller can be regarded as an owner of the KPI as well.

Finally, reviewing the cumulative SLA score every week can support tactical decision making by providing the overall management with accurate and timely information which can trigger timely interventions when considered necessary. Furthermore, by weekly tracking the SLA points, structural problems considering one or more sites can be brought to light. Structural forecast errors should trigger the overall management to collaborate with the fashion reseller to improve the forecasts.

Sickness and absence

In the previous two levels of the PMS, variants of sickness and absence were thoroughly discussed, and the implications of the variables were elaborated. Sickness and absence rates for the overall level of the PMS cannot directly be related to KSFs, but are indirectly related to improving profitability and customer satisfaction. Sickness and absence rates should be reviewed weekly to support tactical decision making. Furthermore, weekly insights are essential for the development of the workforce planning. Weekly sickness and absence can be determined with the measurements done in the individual level of the PMS ($S_{i,s,t}$ and $A_{i,s,t}$). Equations 7.26 and 7.27 present the formulas to determine the weekly sickness and absence rate, respectively.

$$Sickness_w = \frac{Number\ of\ graders\ sick\ in\ week\ w}{number\ of\ graders\ worked\ in\ week\ w} = \frac{\sum_{t \in WD_w} \sum_{i \in G_i} S_{i,s,t}}{\sum_{t \in WD_w} \sum_{s \leq 2} \sum_{h=SH_s[1]} \sum_{i \in G} GH_{i,h,t}}, \forall\ w \tag{7.26}$$

$$Absence_w = \frac{Number\ of\ graders\ absent\ in\ week\ w}{number\ of\ graders\ worked\ in\ week\ w} = \frac{\sum_{t \in WD_w} \sum_{i \in G_i} A_{i,s,t}}{\sum_{t \in WD_w} \sum_{s \leq 2} \sum_{h=SH_s[1]} \sum_{i \in G} GH_{i,h,t}}, \forall\ w \tag{7.27}$$

Similar targets apply for the weekly sickness and absence rates as for the similar daily reported KPIs, 3.5% and 6.5%, respectively. The specific KPIs have two owners, the overall management and the site manager. Both owners can act on the KPIs as well.

The research of Bakker et al. (2003) indicated that both local and overall management are responsible for offering the necessary job resources, which directly influencing sickness and absence rates. Job resources managed by the overall management of Ingram Micro services are for example payment, career opportunities, and job security. Job resources managed the site manager are for example supervisor and co-worker support, role clarity and performance feedback (Bakker et al., 2003). Therefore, both the site manager and the overall management are in the position to improve these KPIs. Finally, the effect of changes in job demand and resources should also be noticeable in the four KPIs described section 7.1.6.

7.4 Overview of the performance management system

In the previous sections, five elements of the PMS framework have been designed in full detail. In total, 24 KPIs have been designed for the three levels of the PMS. Figure 7-1 presents an overview of the complete designed PMS with the detailed design integrated into the PMS framework, providing a visualization of the designed PMS as a whole.

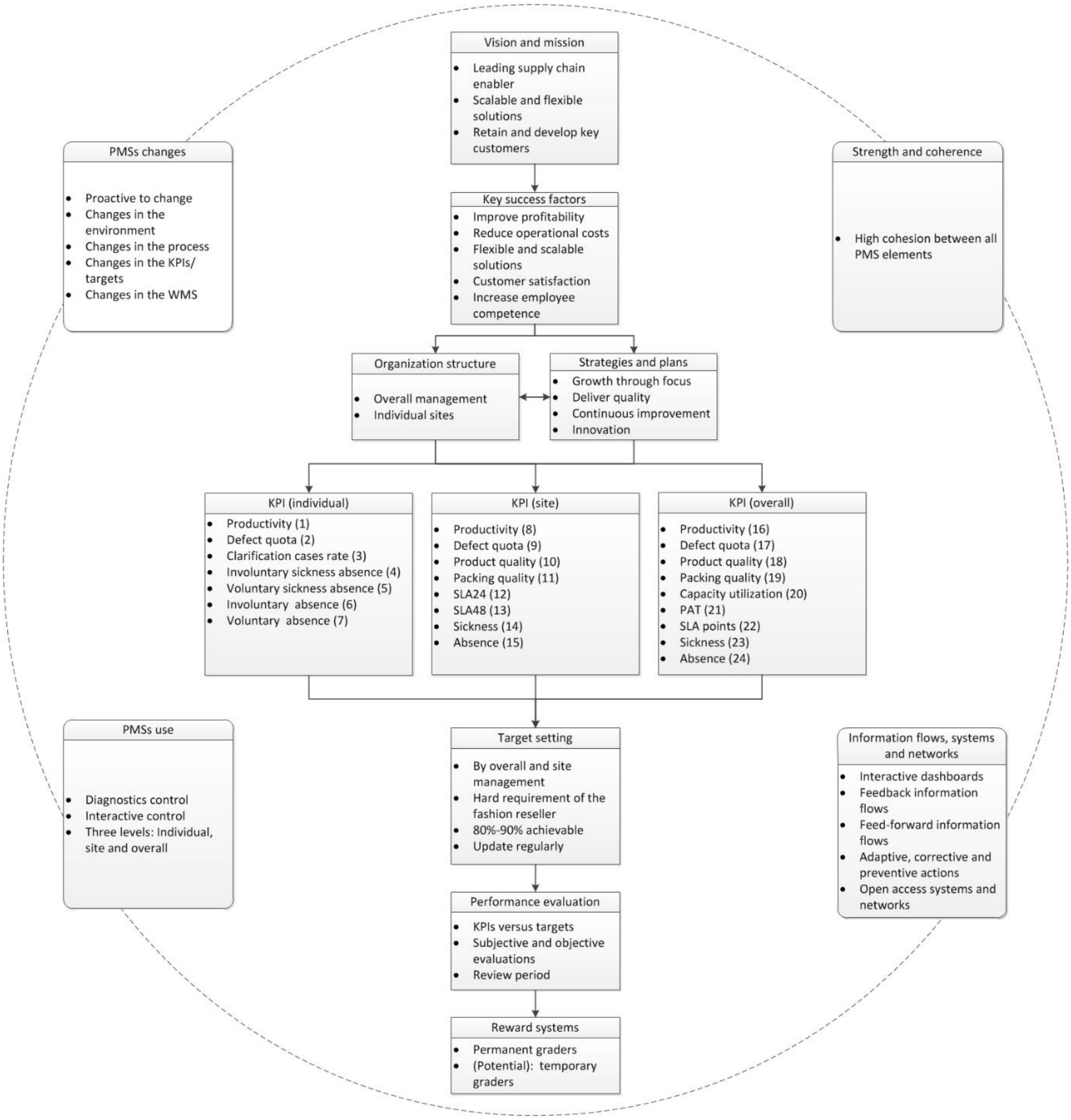

Figure 7-1: Overview of the designed PMS

7.5 Validation of the performance management system

In this section, the different levels of the PMS are validated to amplify the confidence in the designed PMS (Robinson & Brooks, 2010). Historical data will be used to show the potential of the PMS. It should be noted that it is not possible to prove that the PMS results in better performance management compared to the current situation since it is not possible to implement the PMS during this research project. Nevertheless, this section presents the results of applying the designed PMS levels to observe the potential benefits of the PMS. Each level of the PMS will be validated separately.

7.5.1 Validation individual level of the PMS

For the KPIs in the individual level of the PMS, only historical data is available for the KPIs productivity, defect quota, clarification cases rate.

The proposed design for the KPI individual productivity was applied on available historical data of the months April and May in 2018. The results are depicted in Figure F-1, and F-2, presented in Appendix F. Both figures show the ability to detect groups of graders with inferior productivity levels during their shift. Heavily dependent on the applied target level, a group of graders is reported that requires the additional attention of the shift leaders or site manager. This early detection of inferior productivity can assist the management to intervene promptly and focuses the attention to a specific group of graders. Finally, the most gain in utilized grading hours can be obtained by focusing on low productivity graders, due to the diminishing relation between productivity level and grading hours (Figure 5-5).

Similarly, the proposed design for the individual defect quota was applied to the same data (Figures F-3 and F-4 in Appendix F). Similar to individual productivity, the inferior performance of groups of graders can be detected already during the shift allowing immediate interventions.

The final KPI, subject to the validation of the individual level, is the clarification cases rate. The proposed design for the clarification cases was applied to the available historical data (Figures F-5, and F-6 in Appendix F). Unfortunately, only a weeks' worth of data could be obtained since, in the historical data used for the other parts of the analysis, clarification cases were not reported yet. The same conclusions can be drawn concerning the clarification cases rate as were drawn for the other two individual KPIs.

Concluding, by implementing the individual level of the PMS, the site management can detect graders performing below the desired targets already during their shift. Early detection of inferior performance allows the managers to intervene on time. Through validation of the individual level of the PMS, the confidence in the design increased.

7.5.2 Validation site level of the PMS

For the site level of the PMS, eight different KPIs were designed. Due to restriction in the available data, the site level PMS could only be validated based on the following KPIs: productivity, defect quota, SLA24, and SLA48.

The design developed for the site's productivity level was applied to the available historical data from October 2017 to June 2018 (Figures F-7 and F-8 in Appendix F). Using the site level of the PMS, the site manager can observe the differences between the productivity levels of both productivity groups and the total group. The results showed that especially the low productivity group requires additional attention. Furthermore, developments of productivity groups can be monitored easily. Finally, this KPI provides useful information on whether the managerial efforts on the individual level result in the desired effect on the site's productivity level.

Similarly, the proposed design for the site's defect quota was applied to the same data (Figure F-9 in Appendix F). First, daily reviewing the site's defect quota allows the measuring of customer satisfaction each day. Second, daily insight into the site's defect quota allows the manager to detect development from day to day. Due to the sinusoidal pattern in the defect quota over time, an increase or decrease in defect quota over several days can predict the future defect quota. Those results can be used to adapt the dynamic targets for the defect quota in collaboration with the fashion reseller.

The final KPIs subject to validation are SLA24 and SLA48. The design of the KPIs, based on the formulas employed by the fashion reseller, was applied to the available historical SLA data from January 2018 to June 2018 (Figure F-10 in Appendix F). Considering SLA48 first, the SLA48 is always satisfied. Second, SLA24 is only below the target on a few occasions. The site manager should act timely when the SLA24 is below target to avoid getting stuck in a negative spiral, which can be observed for days 67-73 in Figure F-10. Using the site level of the PMS, the manager can observe a negative spiral promptly. Finally, the results suggest that the performance management concerning the SLAs is more than satisfactory.

Concluding, with the site level of the PMS, several effects can be observed. First, differences between productivity groups and development within/between productivity groups can be monitored and reviewed, indicating which groups need additional focus. Second, up- or downwards trends in the defect quota can be detected early, due to the underlying sinusoidal pattern. Finally, it was observed that the SLAs are managed more than satisfactory. However, the site manager should tread carefully when productivity levels change since this can directly influence the scores of SLA24 and SLA48. Through validation of the site level of the PMS, the confidence in the design increased.

7.5.3 Validation overall level of the PMS

For the overall level of the PMS, nine different KPIs were designed. The overall level PMS could only be validated for the following KPIs: productivity, defect quota, product quality, packing quality, PAT, capacity utilization and cumulative SLA points.

The design for the overall productivity level was applied to the available historical data from October 2017 to June 2018 (Figure F-11 in Appendix F). First, implementing the overall level of the PMS results in more detailed information on productivity for the overall management. The results show the differences between the productivity groups. When such signals are observed at other returns sites as well, the need for a structural solution is amplified, and resources can be combined to address the problem.

Similarly, the proposed design for the overall defect quota was applied to the same data (Figure F-12 in Appendix F). First, weekly reviewing the defect quota allows the detection of an up-or downward trend, similar to the site level of the PMS. Furthermore, by comparing the overall defect quota against other sites, differences between regions can be identified, which is considered as useful information for both Ingram Micro Services and the fashion reseller. Finally, higher defect quotas compared to the other return sites may signal the need for improved training programs for specific sites.

For product and packing quality, the design was applied to the available historical data from January 2018 to April 2018. Both KPIs are directly reported by the fashion reseller in the weekly quality feed report. The results were already presented in Figure 5-19, section 5.1.7. Reviewing both the product and packing quality provides insights in the overall ability of graders in a return site to process returns according to the desires of the fashion reseller. The overall management can benefit from such information for assessing the adequateness of the current training programs and control mechanisms at the different return sites. The overall management can initiate improvement programs for specific return sites based on these KPIs.

The design of the KPI PAT was applied to the available historical data from October 2017 to June 2018 (Figure F-13 in Appendix F). This KPI shows the overall management that only a limited amount of graders is able to perform performing above the target. This KPI may justify a lower level of overall productivity due to that the current workforce pool simply cannot reach a higher level of productivity. This KPI may also show the management that the target may be too strict for all productivity related KPIs. Finally, this signals that action should be taken considering the improvement of productivity levels of low productivity graders.

Considering the KPI capacity utilization, the design was applied to the same data (Figure F-14 in Appendix F). Several peaks can be observed reaching capacity utilization levels of up to 90%. When the weekly capacity utilization is reported, the overall management is supplied with information to assess whether capacity reductions or extensions are required. Furthermore, when specific sites work at full capacity frequently, the overall management can discuss the potential of lateral transshipments between sites with the fashion reseller. Lateral transshipments can be used to smooth the capacity utilization amongst sites as an alternative to increasing or decreasing capacity.

Finally, the KPI cumulative SLA points is addressed. The developed design for this KPI was applied to the historical available SLA data from January 2018 to June 2018. The results were already presented in Figure 5.18, in section 5.1.8. Weekly reviewing the cumulative SLA points allows for the timely intervention by the overall management when the site management is unable to control the KPIs at the lower level (SLA24 and SLA48). Based on the results, the site management is perfectly adequate in controlling both the SLA KPIs, requiring no interference of overall management. However, overall management should stay informed in cases where additional assistance is required.

Concluding, the potential of using the overall level of the PMS was shown by applying the KPIs to the available historical data. Implementing the overall level of the PMS results in an improved state of information of the overall management. An improved state of information enables the overall management to focus on specific problems of the sites. In such a way, adequate resources can be provided to tackle problems. Adequate resources include monetary support, in-house support, external consultants and many other options. Through validation of the overall level of the PMS, the confidence in the design increased.

7.5.4 Conclusion

The results in this section showed that the different management levels of Ingram Micro Services could benefit from using the different levels of the PMS. Therefore, it is recommended to Ingram Micro Services to implement the three levels of the PMS for the return handling process. The implementation phase is described in the next Chapter.

8. Implementation

The final phase of this master thesis is the implementation of the design, which will be discussed in this Chapter. The implementation process consists of three phases, described by Mettänen (2005): Establish procedures for ongoing measurements (1), develop and implement facilities for the collection, processing, and reporting of data (2) and, utilize the designed PMS (3). In addition to the implementation process, the potential resistance and costs will be discussed. To finalize this Chapter, the limitations of the design are examined.

8.1 Procedures for ongoing measurement

The first step of the implementation is defining procedures for all required measurements. In Chapter 7, all required measurements and their sources have been discussed. Eleven different measurements are required each day to determine the scores of the KPIs.

Each hour, the processed return items ($PI_{i,h,t}$), processed return orders ($PO_{i,h,t}$), processed defects ($DI_{i,h,t}$) and processed clarification cases ($CI_{i,h,t}$) should be measured for each grader. The measuring of those four measurement is incorporated in the WMS, requiring no additional labor.

Before or during each shift, the absent graders ($A_{i,s,t}$) and sick graders ($S_{i,s,t}$) should be measured. It requires manual labor to determine which graders are sick or absent during a shift. Merely checking which graders did not clock in for their shift does not result in obtaining the required information.

The final five measurements should be measured once a day: short forecasted return orders (F_t), inbound return orders (Ibn_t), inventory at cutoff ($Icut_t$), product quality and packing quality. The daily short forecast of return orders is reported once a week by the fashion reseller, thus, the measurement should only be recorded into the PMS. Furthermore, both the daily inbound return orders and the remaining inventory at cutoff need to be counted manually. The potential of automatically measuring those KPIs should be investigated. Finally, the product quality and packing quality should be measured daily by the responsible shift leader or quality employee at the return site and cannot be automated.

Concluding, compared to the current situating, only measuring the absent and sick graders per shift is additionally required.

8.2 Facilities for collecting, processing and reporting data

The second step of the implementation is to facilitate the collection, processing, and reporting of data, which is mainly dependent on the source of the measurements. For the required measurements, the following sources are required: WMS, quality feed report, weekly forecast report, and manual measurements. For all KPIs except the variables $A_{i,s,t}$ and $S_{i,s,t}$, facilities are in place for the collection of the data. Thus, a registration system to measure the daily sickness and absence of individuals needs to be developed.

To process the data, a data warehouse can be used to store and analyze the data (Dedić & Stanier, 2016). All variables registered by the WMS, are already automatically stored in a data warehouse. For the other variables, concerning the manual measurements and the measurements reported by the fashion reseller, those should be registered in a data warehouse by either Ingram Micro Services or by the fashion reseller. The required data warehouse(s) can be developed internally by Ingram Micro Services. Furthermore, storing all the measurements in data warehouses enables the production of the performance reports (dashboards) automatically. Ingram Micro Services has substantial IT resources with which customized performance dashboards can be developed. The only requirement is that the data is stored in a data warehouse. Finally, for Ingram Micro Services the main difficulty lays within the accessibility of data warehouses in order to integrate all data. Close collaboration with the fashion resellers is required for this implementation step.

8.3 Utilize the performance management system

The final phase of the implementation is the actual use of the PMS. The site managers, shift leaders, and overall management should be trained in using the different levels of PMS in order to maximize its usefulness. It is essential that all different managers understand the benefits of the designed PMS. Furthermore, it is important to note that the PMS changes when the organization changes. As an example, the change of WMS resulted in an additional KPI that should be monitored. Therefore, the measures and targets should be revised regularly. Unfortunately, the PMS has not been implemented during the master thesis.

8.4 Resistance to the implementation

Bourne et al. (2000) discovered three main obstacles to implementations: Resistance to measurements, computer systems issues, and top management commitment. First, resistance from site managers and shift leader can be expected due to the additional measurements of sickness and absence of graders. However, those KPIs are of vital importance due to the strong relation with motivation and willingness of the graders (Bakker et al., 2003). Motivation and willingness of graders are essential for the KPIs productivity, defect quota and clarification cases rate. The second obstacle may come from the fashion reseller due to the lack of open access to data stored in the WMS. When the fashion reseller is not able or willing to provide real-time data, the implementation of the individual and site level PMS is unattainable. Close collaboration with the fashion reseller is required to enable real-time data availability. Whenever required, Ingram Micro Services can assist the fashion reseller with their expertise on WMSs. The last obstacle proposed by Bourn et al. (2000), is the commitment of top management (overall management). The commitment of the overall management is essential to the implementation of the PMS (Frizelle, 1991). Overall management commitment is required to stress the importance and usefulness (benefits) of the PMS on the different management levels. Other more pressing priorities for the overall management may hinder the commitment. Finally, another potential source of resistance is the costs to develop and operate the PMS, which will be discussed in the next section.

8.5 Costs of the implementation

This section presents a brief overview of the expected costs of implementing and operating the designed PMS. For the implementation of the PMS, the main costs will be incurred in the development and integration of the data warehouses, which requires a one-time investment of resources. For the more substantial part of the KPIs, the systems are already in place that perform the automated measurements. An additional data warehouse needs to be developed for storing all the data that is not incorporated in the WMS. However, costs can be kept at a minimum since Ingram Micro Services has in-house expertise that specializes in the development of data warehouses. Furthermore, Ingram Micro Services already employs software programs that can develop customized reports based on several separate data warehouses. Thus, no additional investments are required to develop the performance reports.

Considering the costs of operating the PMS, a few projections are presented. First, the additional costs will be discussed. Subsequently, the direct cost savings will be addressed. By implementing the PMS, additional time needs to be devoted to the measurement of the sickness and absence of individual graders each shift. Shift leaders can be utilized for those measurements, costing significantly less than the members of the site management. For the other measurements, no changes are made in measurement procedures, meaning that no additional costs are incurred. However, it should be noted that the manual measurements are considered more expensive than the other measurements. Furthermore, the overall management will spend more time reviewing the performance when the proposed design is utilized, simply because the review period is shortened from a month to a week. Unfortunately, it is nearly impossible to provide an accurate estimate of those costs.

Considering direct cost savings, it is expected that site managers will spend less time creating performance reports and evaluating performance. In the current situation, the site managers are required to filter out inferior performing graders manually. By implementing the PMS, inferior performing graders can be identified with significantly less effort.

Finally, it is believed that the additional costs of the additional measurements are balanced out by the costs saved due to the time savings in the creation of performance report and evaluating the performance, resulting in no additional costs of operating the PMS in a return site.

8.6 Limitations

There are several limitations of this thesis that can affect the integration of the designed PMS. The limitations are discussed in short below.

Data availability

Only a limited amount of detail was available for the data concerning the processing of return orders. First, only the monthly KPI report contains information on the productivity levels of permanent and temporary graders, where a statistical difference was found between the two types of graders. Though, no further analysis to research within-group differences could be performed due to the low aggregation level of the monthly data. Furthermore, no identification tags for individual graders are used in both WMSs to measure the hourly performance. Only the respective workstations were reported. This impedes the possibility to analyze individual productivity over time. The claim that productivity is positively related to the duration of employment could therefore not be verified. To improve the designed PMS further, productivity groups should be investigated in more detail to validate whether the most appropriate grouping method was applied in the design.

Second, no information was available on the product categories of processed return items. The analysis of the relationship between defect quota and product categories could have provided additional insights. A deeper understanding of the defect quota can aid in understanding the sinusoidal pattern in the defect quota over time. The designed PMS can thus be improved proactively through analyzing the relationship between the defect quota and product categories.

Networks and systems

During the design of the PMS levels, restrictions regarding the WMSs have not been taken into account. For return sites operating with the WMS of the fashion reseller, the implementation of the individual and site PMS levels will only be possible when the fashion reseller enables real-time data availability. The effects of managing operational performance in a retrospective manner have not been researched in this master thesis, but it is assumed to be less effective since the early detection of inferior performance is not possible. Early warnings signals are considered as a significant strength of the designed PMS.

Application and testing

A company case study was performed to design a PMS for reverse logistics operations. The specific type of returns, the revenue model and the specific type of customer had a substantial influence on the designed PMS. Utilizing the designed framework for different customers has not been included in the research. Therefore, future research should determine whether the design can be applied to other fashion customers, customers active in different markets, and customers with different revenue models and cost structures.

9. Conclusion and recommendations

In this Chapter, the answer to the research question is summarized first. Second, the academic reflection and practical contributions of this thesis are presented. Finally, recommendations for future research directions and Ingram Micro Services are presented.

9.1 Answers to the research questions

In the third Chapter, the research question for this master thesis was developed which will be answered in this section. The main research question was formulated as follows:

> *What is the optimal level of detail of the global performance management system in order to assess and improve the performance of the return handling process executed by Ingram Micro Services at different European return sites?*

With an optimally designed PMS, all information requirements of the different management levels of Ingram Micro Services are satisfied at a minimum of costs. To satisfy all information requirements, the right KPIs must be incorporated in the PMS. These KPIs must be reported when required and should be reviewed systematically. No single optimal level of detail could be determined for the global PMS, due to the substantial different information requirements of the management levels. This led to the development of three separate levels within the global PMS, with each level designed explicitly according to the information requirements per level. The optimal level of detail per level has been determined by deriving KPIs from Ingram Micro Services' objectives, KSFs, strategies, plans, and management processes. The level of detail for a KPI considers the combination of aggregation level and the review period.

The first level of the PMS, the individual level, has been designed for operational decision making and manages the performance of individual graders per day and over time. Daily performance can be reflected by three KPIs: productivity, defect quota and clarification cases rate. All three KPIs are reviewed hourly according to the designed guidelines, enabling the early detection of inferior performance amongst graders. For performance over time, the operationalized KPIs for (in)voluntary (sickness) absence of Steel (2003) were incorporated to manage the job demands and resources of graders, which is essential to prevent burnouts and stimulate the engagement of graders (Demerouti et al., 2001).

The second level of the PMS, the site level, has been designed for the operational decision making and manages the performance of the site in general. To motivate the choice of dividing the first and second level, all KPIs of interest to the fashion reseller should be reported on the site level. The fashion reseller is interested in the performance of the complete site, not in the performance of individual graders. The first KPI for this PMS level, the productivity of graders, should be managed per shift. Two groups within the set of graders were discovered, low and high productivity groups, resulting in an additional level of detail for this KPI. Next, the following KPIs have been incorporated to monitor customer satisfaction: defect quota, product quality, packing quality, SLA24 and SLA48. As stated previously, those KPIs should be aggregated at the site level and reviewed daily. Finally, the sickness and absence rate should be reviewed each shift, to assess the available capacity and improve the workforce planning process.

The last level of the PMS, the overall level, has been designed for the tactical decision making of the site management and overall management. The overall level of the PMS manages the performance of the multiple return sites. The overall level of the PMS enables the benchmarking of performance against other sites and allows to detect strengths and weaknesses amongst the sites. In such a manner, organization learning is stimulated. All KPIs should be reviewed weekly to support tactical decision making. Productivity is incorporated similarly as in the previous level, presenting the weekly averages of the low and high productivity groups. Furthermore, at the respective site, there are difficulties with finding adequate new graders, troubling the improvement of the overall workforce pool. Therefore, the KPI PAT is included, reflecting the overall performance of the workforce pool. The KPIs defect quota, product quality, and packing quality are of significant importance to the fashion reseller, and should therefore be reported to the overall management as well. Additionally, the KPI cumulative SLA points is included to monitor the SLA violations per site. The cumulative value within a month should be monitored closely to prevent significant financial penalties. This KPI also signals the forecasting errors of the fashion reseller to the overall management. Structural inferior performance on the KPIs important to the fashion reseller is detrimental for customer satisfaction. Therefore, those KPIs are of paramount importance. The KPI capacity utilization per site is included, enabling the overall management to decide on capacity decisions such as lateral transshipment to sites with a lower capacity utilization during peak seasons. Finally, the sickness and absence rate should be reported to the overall management to review the job demands and resources offered at each site.

Concluding, three different aggregation levels for the PMS were developed, including three aggregation levels for the KPIs and five different review periods forming in total seven different levels of detail of the global PMS. On a final note, a great deal of similarity can be observed considering the incorporated KPIs of the PMS levels. However, each KPI has been designed for a specific purpose and use, resulting in three unique PMS levels.

9.2 Academic reflection

This research presents the design of a PMS suitable for reverse logistics operations where business performance analytics, control theory, DDM and performance management have been integrated. The core of this master thesis is the developed and applied design process. Considering the employed design to develop the required PMS elements, the model of Leinonen (in Mettänen, 2005) was used as a foundation. In this research, two enhancements have been incorporated into the model of Leinonen to develop an improved design framework. First, in the original model of Leinonen, a strict hierarchical structure is intended to push down the KPIs from top management to the lower levels. However, due to the distributed decision making and the mutual interdependence of stakeholders, the strict hierarchical structure was replaced with a DDM system to ensure the propagation of KPIs amongst the stakeholders. Second, it was observed that there is no specific stage included in the model of Leinonen to validate the design. Therefore, in this research, a validation stage was added to determine the potential of the designed PMS levels and thus, validating the overall design.

9.3 Practical contribution

This master thesis has practical relevance for Ingram Micro Services as the developed levels of the PMS can provide each level of management with the required information to improve the management of performance. Additionally, the PMS supports the structural application of control loops on site level. Furthermore, the PMS enables Ingram Micro Services to detect performance deviations earlier, thus reducing the time to intervene for both the site management and overall management. Finally, the overall level of the PMS allows to benchmark performance against other sites, which may stimulate intra-organizational learning and aids in finding common strengths and weaknesses of the sites.

9.4 Recommendations for future research

The recommendations for future research have been are summarized in this section.

- The PMS was designed based on a single case study. Future research could test the proposed design in different contexts (other fashion resellers, customers with different cost structures, customers active in different markets, customers with different WMSs, etc.).
- The PMS was designed under the assumption that real-time data is available. However, future research should investigate the potential of the PMS to manage operational performance in a retrospective manner.
- During the research, the designed PMS could only be validated using historical data. By performing a longitudinal study, the medium and long-term effects of the PMS can be explored.
- For a more accurate evaluation of the defect quota, a deeper understanding of what causes the fluctuations in the defect quota is required, apart from the effects of graders. Future research should analyze whether the defect quota differs per product category and geographical region.
- In this master thesis, control theory is used to model the decision-making process of site managers. Future research should investigate further applications of control theory in reverse logistics. This research could be extended by examining the potential of using control theory for the development of decisions rules to automate decision making.

9.5 Recommendations for Ingram Micro Services

In this master thesis, several recommendations are provided for Ingram Micro Services, which are summarized in this section.

- Implement the three PMS levels at the return sites to improve the performance management.
- Investigate the possibility to integrate the warehouse management system (WMS) of the fashion reseller with the WMS of Ingram Micro Services to create a higher level of data transparency, enabling the implementation of the individual and site PMS levels at the return sites operating with the WMS of the fashion reseller.
- Include personal identification tags to link performance data directly to graders instead of to workstations. This enables the site management to observe the learning curve of the new grader effortless and monitor the development of performance over time of all graders without additional work.
- Investigate the possibility of different productivity groups within the set of graders that may replace the applied grouping method in order to improve the designed PMS.
- Investigate the possibility to extend the WMS of the fashion reseller, allowing regular graders to process a subset of the clarification items. If the clarification cases remain troublesome for the return site, future research should determine whether this subprocess should be included in the PMS as a separate level.
- Investigate the possibility to automate the manual counting of inbound return orders and the number of outstanding return orders after shift two. By automating both measures, counting errors can be minimized and time can be saved.
- Define structural improvement plans for all KPIs, which contain specific actions for specific situations of inferior performance for specific groups of graders.
- Define a set of actions that can be utilized as a result of high rates of (in)voluntary (sickness) absence. The theory of the JD-R (Demerouti et al., 2001) should be used for guiding the development of actions.

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Appendix A: Statistical process control of the productivity

This appendix presents the equations used to develop the control chart and the process capability scores, presented in Chapter 2. All equations are derived from the work of Montgomery (2009)

Equations control chart

To develop the control chart, nine samples (m) were used consisting each of four measurements (n), one for each return site. Each measurement (x) represent the average monthly productivity level of a return site.

$$\bar{x} = \frac{x_1+x_2+\cdots+x_n}{n}, \text{ n=sample size} \quad \text{(A.1)}$$

$$\hat{\mu} = \bar{\bar{x}} = \frac{\bar{x}_1+\bar{x}_2+\cdots+\bar{x}_m}{m}, \quad \text{(A.2)}$$

$$R = x_{max} + x_{min} \quad \text{(A.3)}$$

$$\bar{R} = \frac{R_1 + R_2 + \cdots + R_m}{m} \quad \text{(A.4)}$$

$$\hat{\sigma} = \frac{\bar{R}}{d_2}, (d_2 = 2.059 \text{ for n=4}) \quad \text{(A.6)}$$

$$UCL = \bar{\bar{x}} + A_2 * \bar{R} \quad \text{(A.7)}$$

$$CL = \bar{\bar{x}} \quad \text{(A.8)}$$

$$LCL = \bar{\bar{x}} - A_2 * \bar{R} \quad \text{(A.9)}$$

$$\widehat{C_p} = \frac{USL-LSL}{6\hat{\sigma}}, \quad \text{(A.10)}$$

$$\widehat{C_{PK}} = \min\left(\widehat{C_{PL}}, \widehat{C_{PI}}\right) = \min\left(\frac{USL-\hat{\mu}}{3\hat{\sigma}}, \frac{\hat{\mu}-LSL}{3\hat{\sigma}}\right) \quad \text{(A.11)}$$

Appendix B: Process model

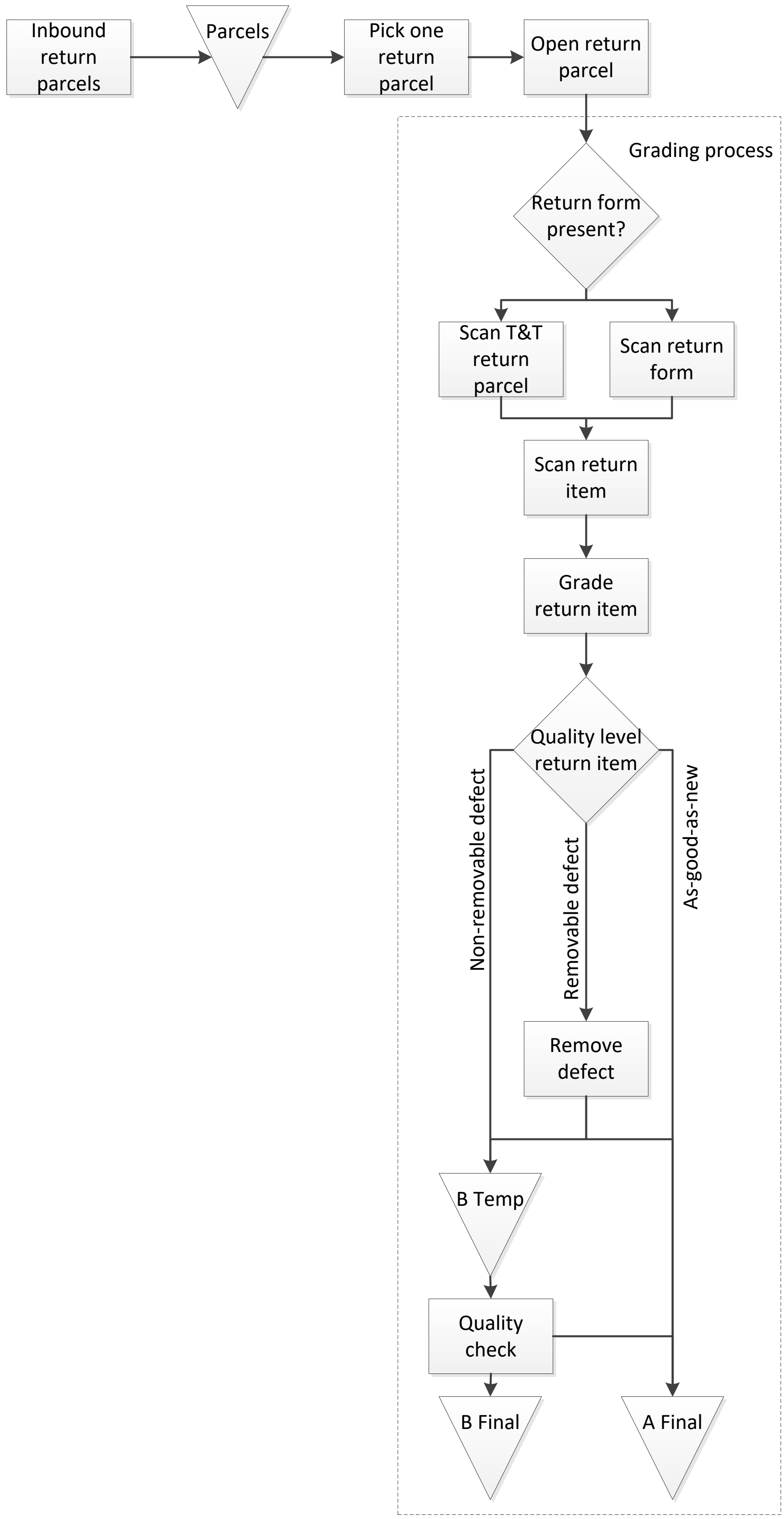

Figure B-1: Process model of the return handling process

Appendix C: Cost related to training

The cost related to training new graders consists of two major factors: Cost of the instructor and the costs related to efficiency loss. Table 8 presents all variables required to determine the costs related to training new graders, applicable to all sites. It is assumed that the hourly costs of new graders are equal to the hourly instruction cost and that a grader is trained for 5 days.

Variables	Definition
$\boldsymbol{L}$	Site location, $l \in \{1, .., sites\}$
$\boldsymbol{R_l}$	Revenue per processed item at site l, $l \in L$
$\boldsymbol{C_{T,l}}$	Cost per hour of a temporary worker at site l, $l \in L$
$\boldsymbol{P_{target}}$	Target level of productivity set companywide at 100 UPH
$\boldsymbol{S_l}$	Length of shift at site l, $l \in L$
$\boldsymbol{T_l}$	Amount of training spots per shift at site l, $l \in L$

Table 8: Variables training graders

Equations B.1, B.2 and B.3 (piecewise function) show the exact formulas to calculate the training cost for all sites. For the site in question, the training costs for a new grader were determined.

The additional training costs are expressed as a percentage costs corresponding to 1 FTE per month of temporary graders.

$$Training\ cost = Instruction\ costs + Effiency\ loss \tag{B.1}$$

$$Training\ cost_L = 5 * S_l * \frac{C_{T,l}}{T_l} + R_l * \sum_{week=1}^{4} 5 * S_l * (P_{target} - Productivity(week)) \tag{B.2}$$

$$Productivity(week) \begin{cases} 42.9, week = 1 \\ 64.3, week = 2 \\ 78.6, week = 3 \\ 92.9, week = 4 \end{cases} \tag{B.3}$$

$Training\ cost = 5 * 8 * \frac{C_T}{4} + \mathrm{R} * \sum_{week=1}^{4} 5 * 8 * (100 - Productivity(week)$ ≈70% of the costs of 1 FTE per month of a temporary grader.

Appendix D: Modified performance measure record sheet

Modified performance record sheet (Neely et al., 1997)	
Title of the measure	Is the title self-explanatory? Does the title explain why the measure is important?
Purpose	What is the aim of this measure? What behavior does this measure stimulate?
Target	What level of performance is desirable? What time would it take to reach this level of performance? What is a market benchmark?
Formula	How can this be measured? Is the formula clear? Is it clear what data is required? What behavior does this calculation stimulate? How accurate is the data that is needed? How much information is lost when using this measure?
Frequency of measurement	How often should the data be collected? How often should the measure be reported?
Who measures	Who is responsible for data collection and reporting?
Source of data	Where is the data collected from?
Who owns the measure	Who is responsible to make sure the measure is improved?
What do they do	What are the actions they take to make sure it improves?
Who acts on the measure	Who leads the management process?
What do they do	What is the general management process based on the outcomes of the measures?
Frequency of review	How often is the measure reviewed?
Notes and comments	Any additional notes and comments

Table 9: Modified performance measure record sheet

Appendix E: Review period of individual performance

In this Chapter, the review period for individual performance is analyzed in full detail. In the analysis, there is focused on developing appropriate guidelines for reviewing the individual performance hourly.

Performance assessment

When assessing performance per hour, every hour should determine whether a grader is performing below or above target. However, to generalize the results and product early warning signals of inferior performance, a parameter needs to be determined for the number of hours a grader is performing below the target that leads to concluding that a grader is performing inferiorly. This parameter will be referred to as the minimal hours performing below target (MHPBT). It is key to understand that assessing performance hourly can results in false positive and false negative conclusions, dependent on the chosen MHPBT

> *False positive:* Concluding that a grader is performing below target while the average performance is above target
>
> *False negative:* Concluding a grader is performing above target while the average performance is below target

It should be noted that that false positives conclusions are preferred over false negative conclusions, in order to detect all graders performing below the target level.

To determine appropriate levels for the MHPBT of the KPIs productivity, defect quota and clarification cases rates, the false negative and false positive rates for different values of the MHPBT have been analyzed. The data used for validating the three KPIs have been used to study the MHPBTs as well. For the target levels, the monthly averages have been used. Figures E-1, E-2, and E-3, present results of the analysis.

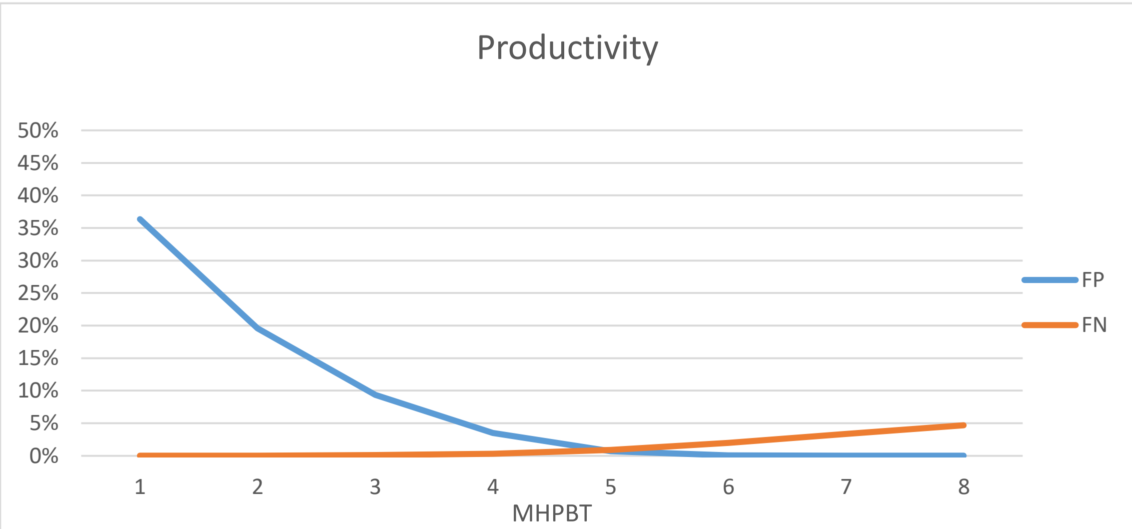

Figure E-1: Productivity: False positive and false negative analysis

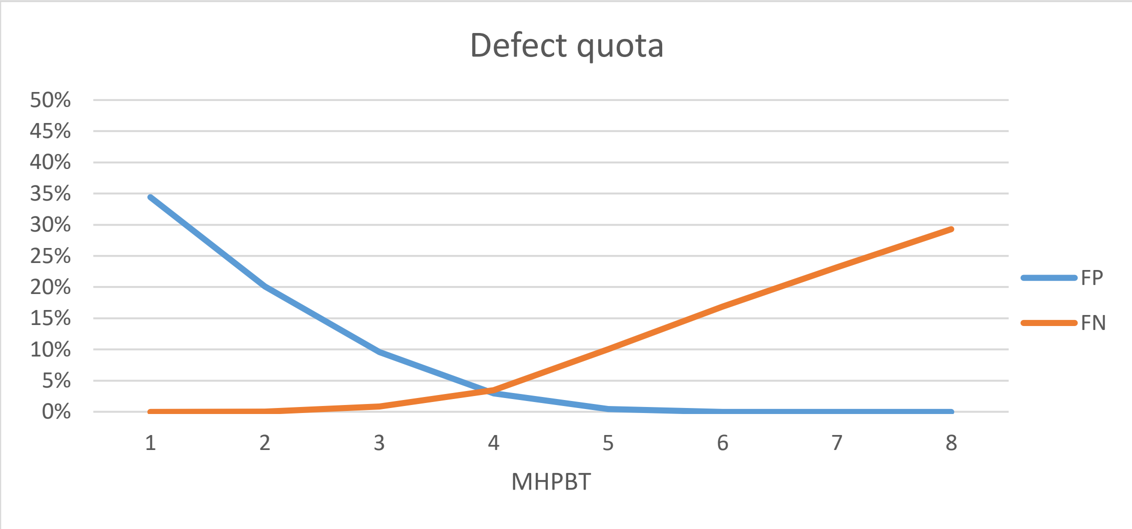

Figure E-2: Defect quota: False positive and false negative analysis

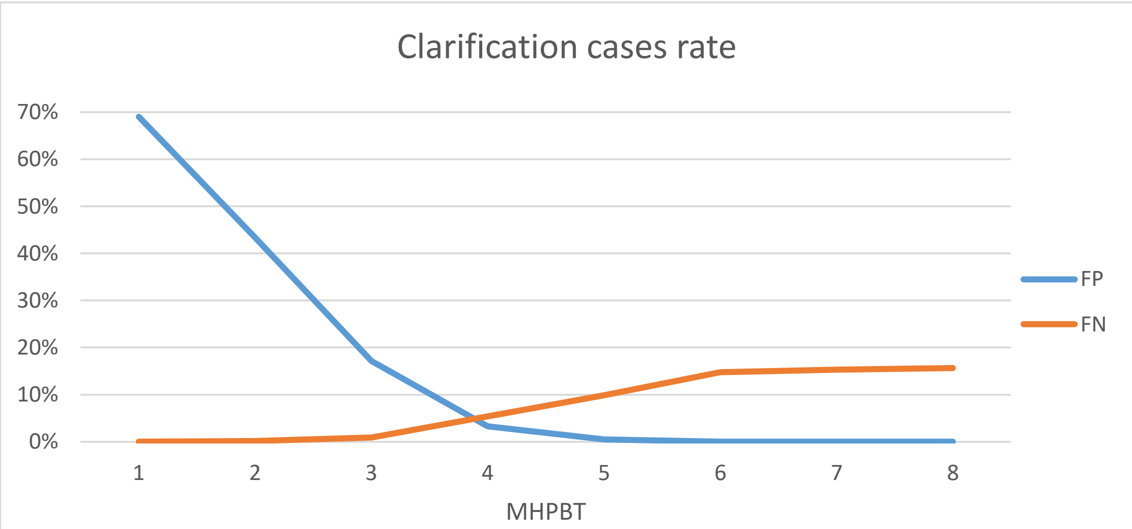

Figure E-3: Clarification cases rate: False positive and false negative analysis

The optimal values for the MHPBT for the productivity, defect quota and clarification cases rate are 4, 3 and 3, respectively. Therefore, for reviewing the individual performance KPIs each hour, the optimal MHPBT values can be used as guidelines to determine the inferior performance of graders. In practice, this means that a grader is reported as an inferior performer when he or she does not perform according to target for three or more hours (defect quota and clarification cases rate) or four or more hours (productivity) during their shift.

Appendix F: Validation PMS levels

Individual level

Productivity

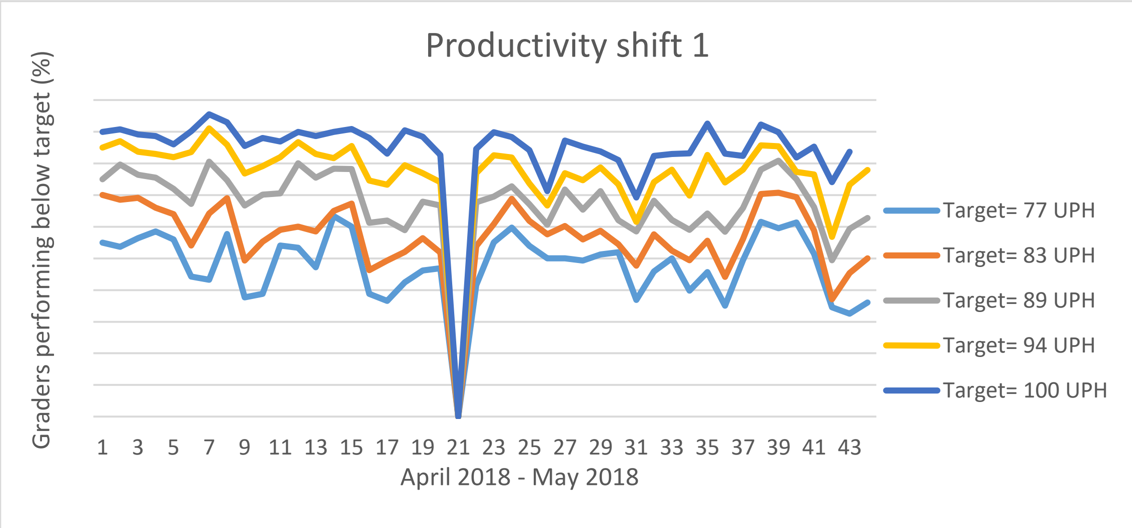

Figure F-1: Validation productivity per individual per hour (shift 1)

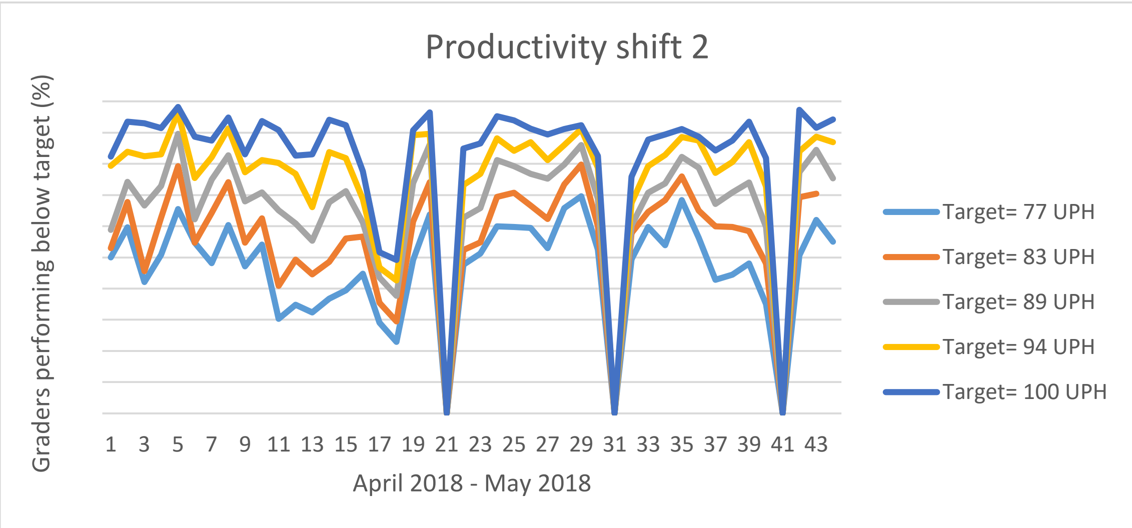

Figure F-2: Validation productivity per individual per hour (shift2)

Defect quota

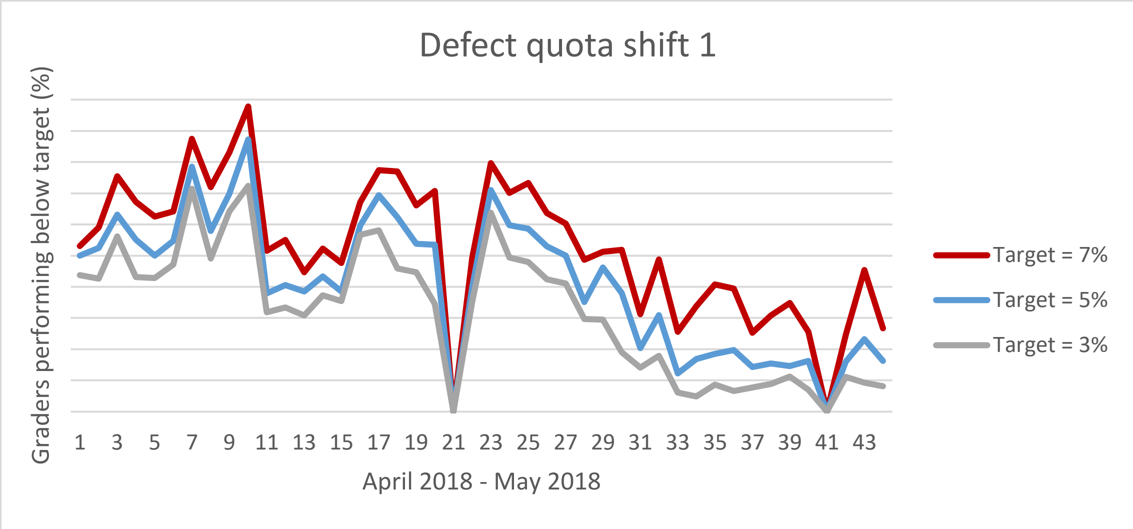

Figure F-3: Validation defect quota per individual per hour (shift 1)

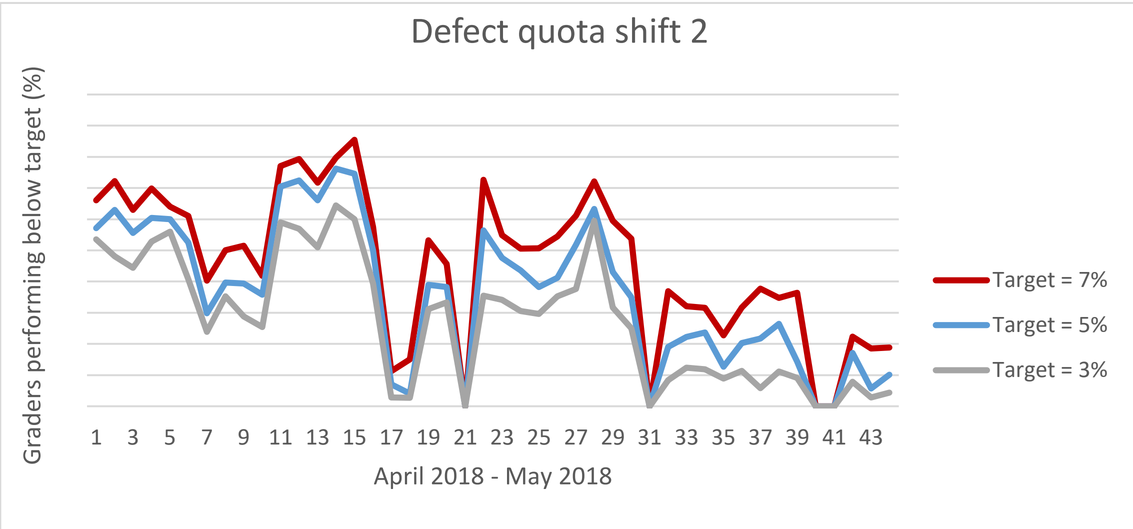

Figure F-4: Validation defect quota per individual per hour (shift 2)

Clarification cases rate

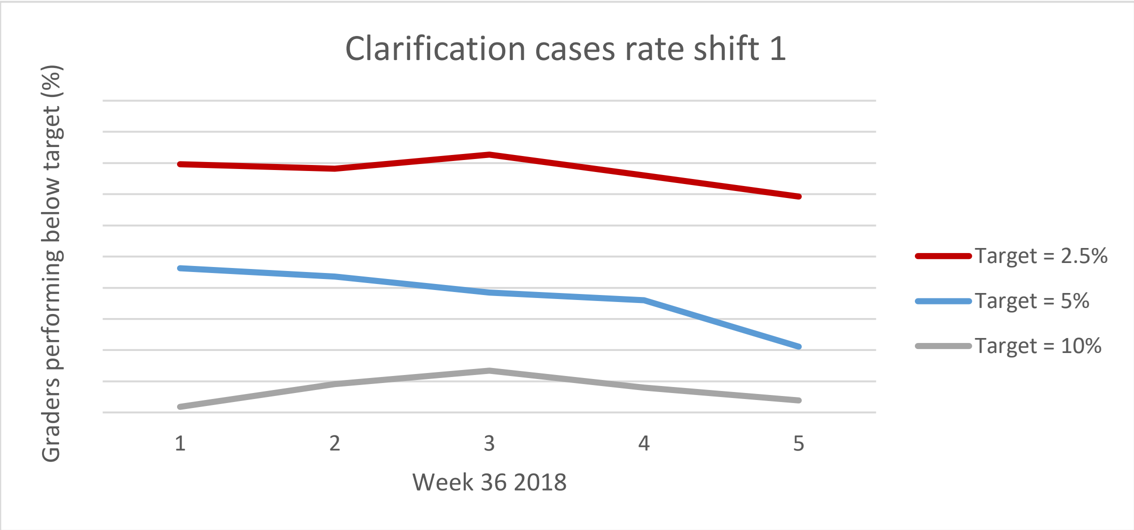

Figure F-5: Validation clarification cases rate per individual per hour (shift 1)

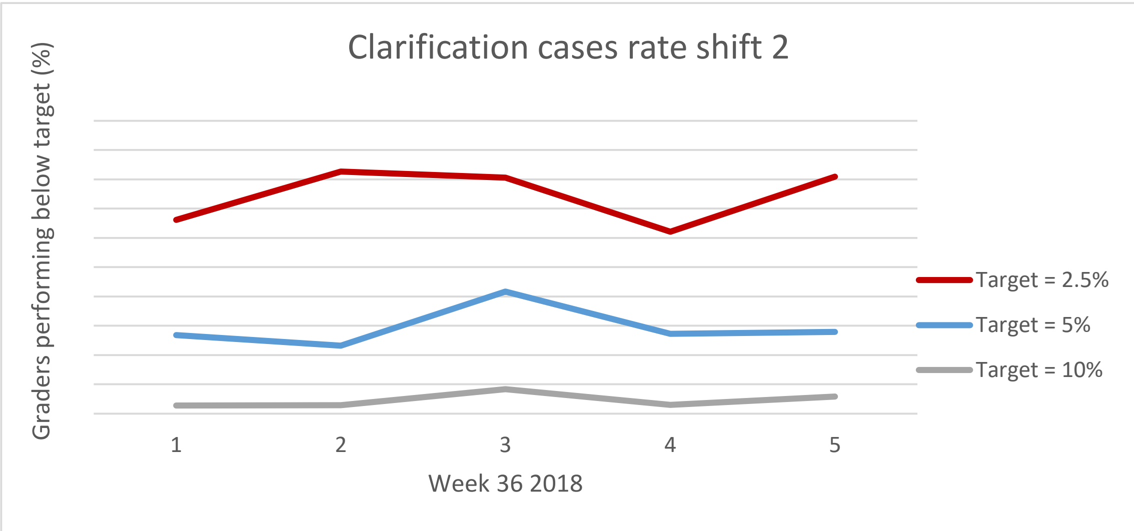

Figure F-6: Validation clarification cases rate per individual per hour (shift 2)

Validation site level

Productivity

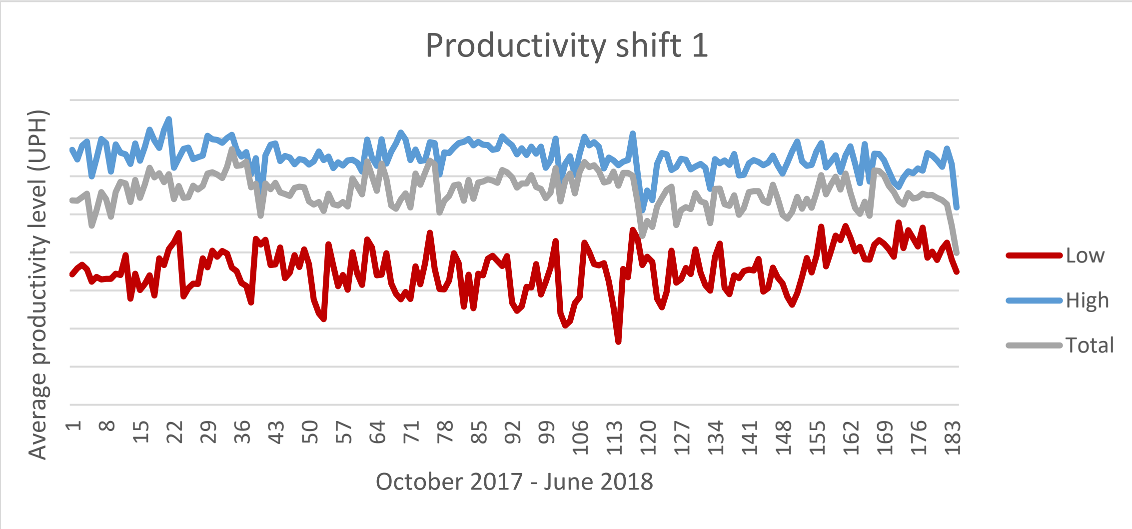

Figure F-7: Validation productivity per productivity group per shift (shift 1)

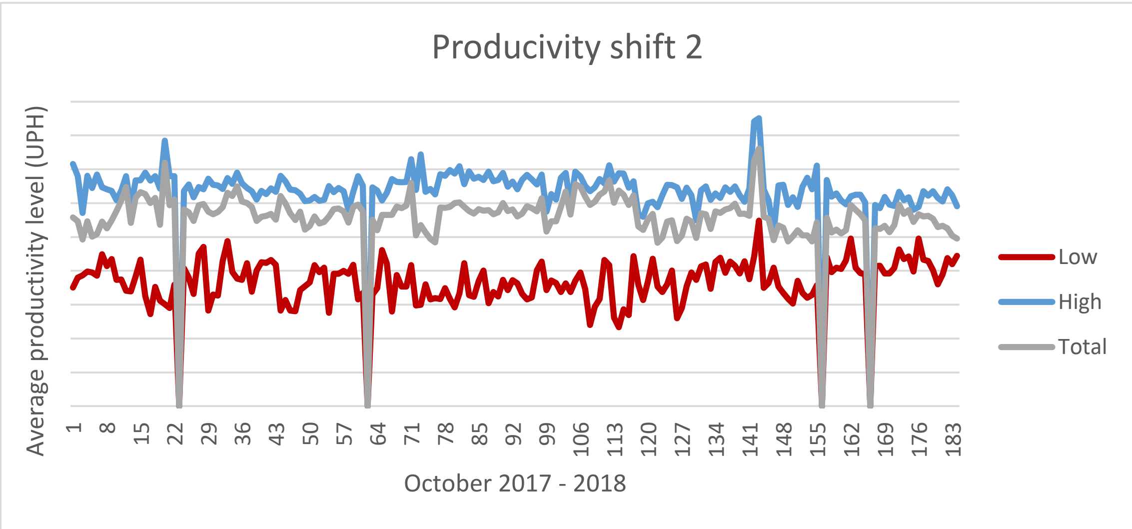

Figure F-8: Validation productivity per productivity group per shift (shift 2)

Defect quota

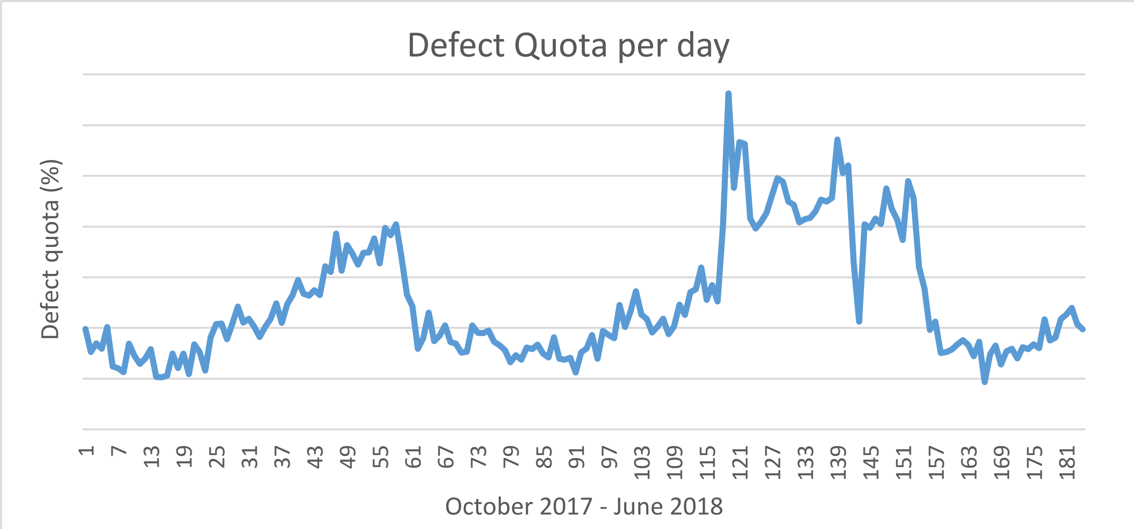

Figure F-9: Validation defect quota per day

SLA24 and SLA48

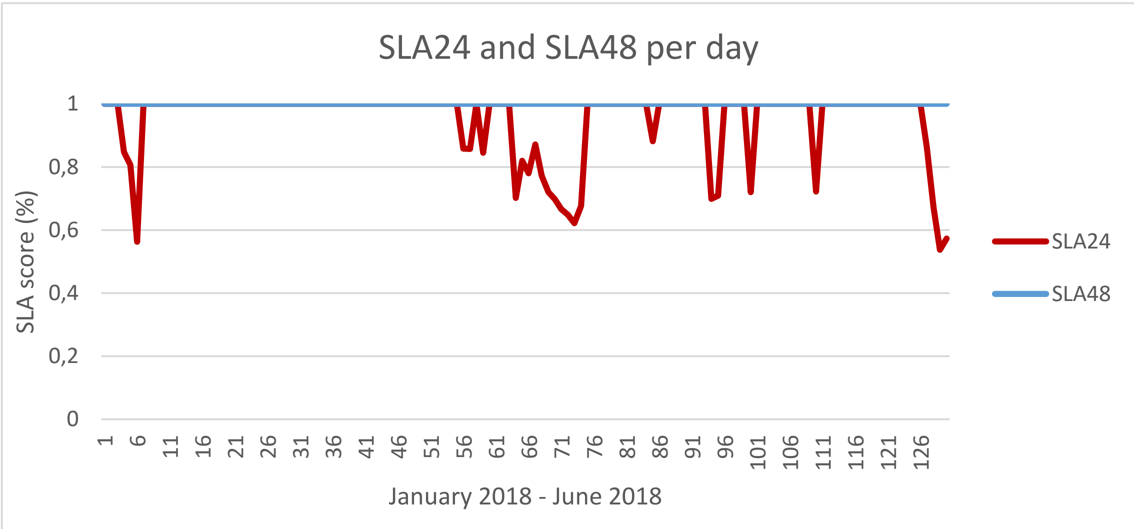

Figure F-10: Validation SLA 24 and SLA48 per day

Validation overall level

Productivity

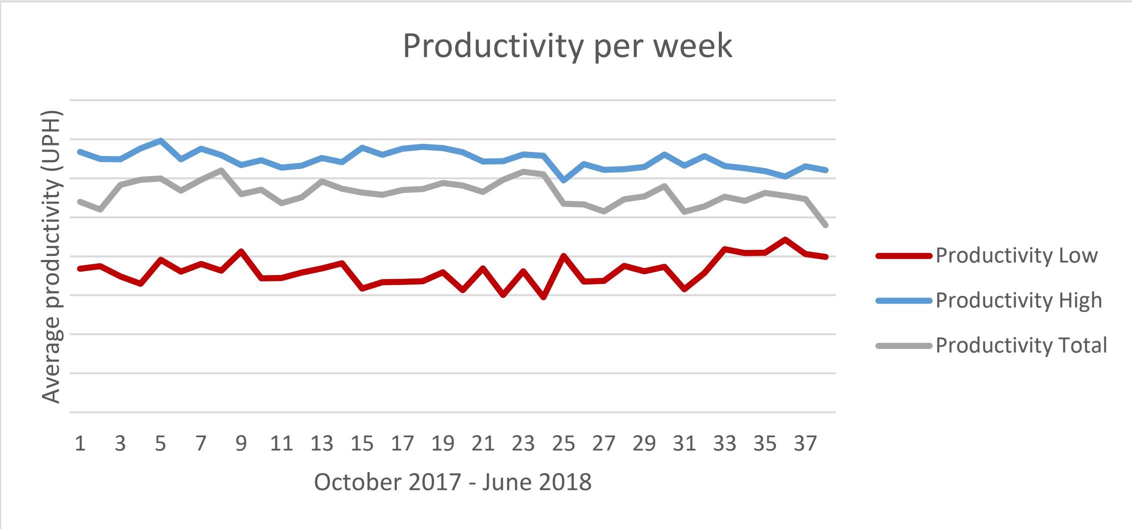

Figure F-11: Validation productivity per productivity group per week

Defect quota

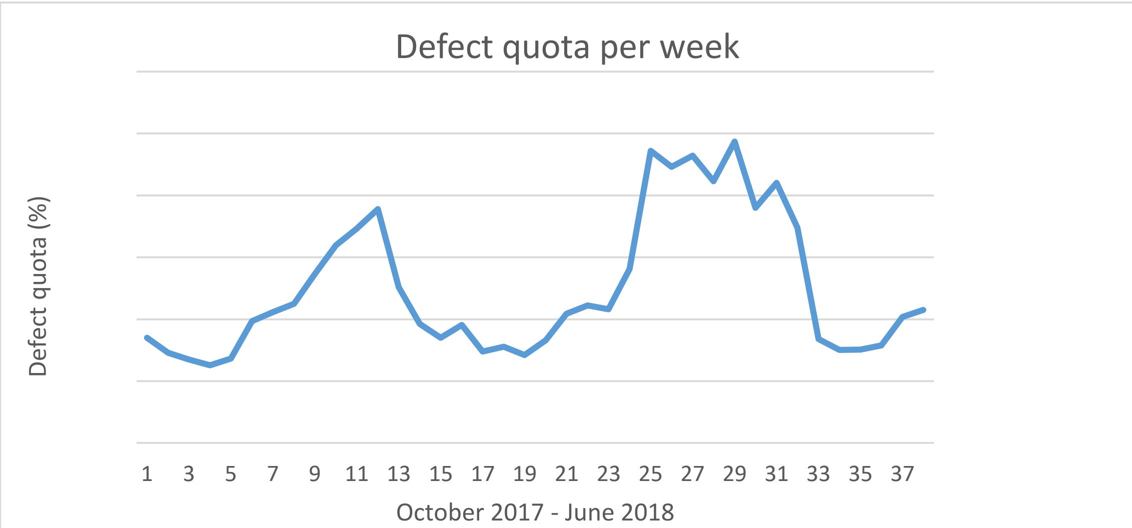

Figure F-12: Validation defect quota per week

PAT

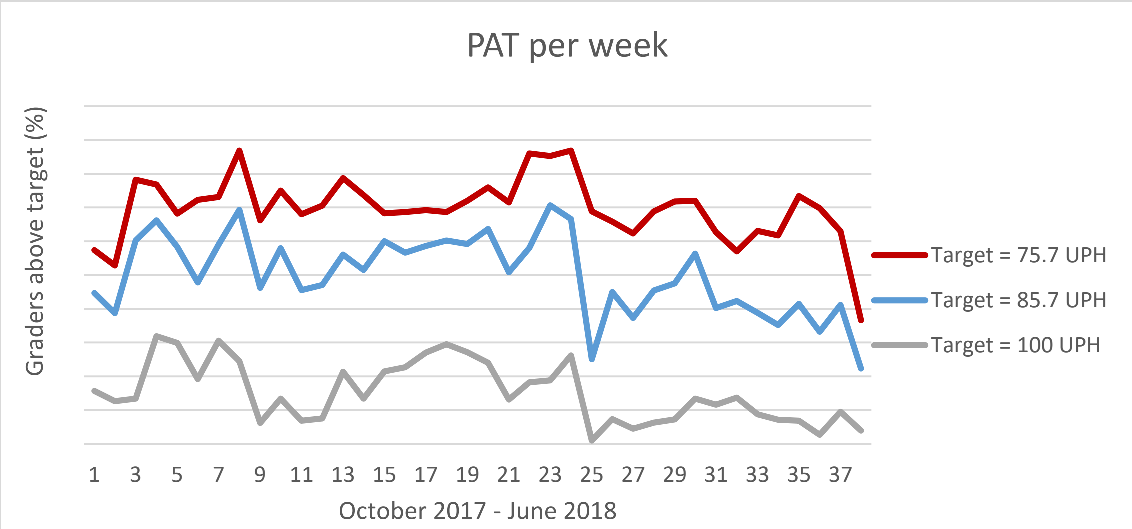

Figure F-13: Validation PAT per week

Capacity utilization

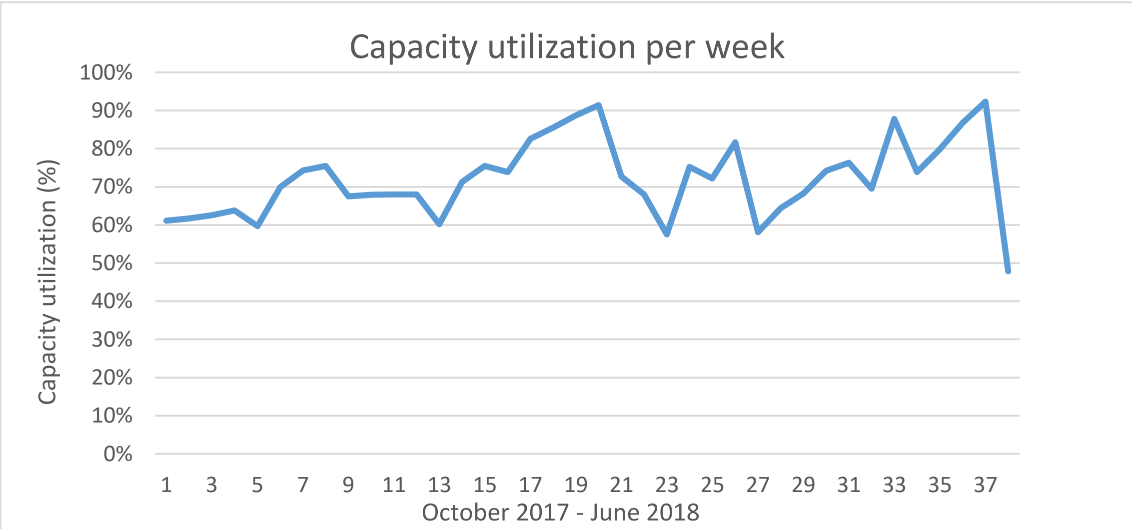

Figure F-14: Validation capacity utilization per week